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NEW YORK, MAY, 1894.

EDITORIAL NOTES.

THE Brazilian rebellion is at an end; and there seems to be no reasonable doubt but that the great and formidable *Aquidaban* has succumbed to the attack of a torpedo boat that came out of the fight unharmed. The vessel was all right as long as shots came through the air, and she passed to and fro before the forts in Rio Janeiro harbor with impunity; but the underwater attacks were too much for her, and down she went. This is what we all thought and figured upon, and little has been learned; but how about the efficiency of the *Nictheroy?* We must once more re-echo our regret that she could not have had a finger in the pie and at least fired one shot just to show whether the dynamite gun was a real weapon or a scarecrow.

THE question, "What are we coming to?" may well be asked regarding the criticisms now being heaped upon the navies of the world. Commencing with the nautical opera of "H. M. S. Pinafore," we have had one long series of ridicule and adverse scientific criticism of the British Navy, culminating in the "Cruise of the Mary Rose" and the topical songs of the London music halls. Then comes the latest shock of all in the scathing criticisms of the committee of the French Chamber of Deputies on the navy of France, of which the English critics have spoken so highly. At home we have received a rap on the knuckles in the examination of the *Machias* and *Castine*, but are assured that everything else is all right. Let us hope that it is.

THE discussion by the members of the American Society of Mechanical Engineers, published in another column, purports to bring out the fact that we really know very little about the behavior of materials below the elastic limit within the range of those strains which are employed in machinery and structures, as evidenced by the high factor of safety or "factor of ignorance," as one speaker put it. Would it not be just as proper to say that we do not know the strains to which a machine doing a given piece of work is subjected, and therefore cannot calculate the strength required of the material? Who, for example, can calculate the strains on the various parts of a steam excavator working in any soil? or who figures closely on the stresses applied to the various parts of a locomotive running at high speed over a crooked track? Twelve to one should give a fair margin of safety; but even with this we do occasionally hear of rods and frames breaking. Taking our ignorance of the behavior of metals and then squaring it by our ignorance of the stresses we are applying to it, we certainly do have a pretty heap of ignorance to compare with what we really know.

WATER-TUBE BOILERS.

THERE is probably no subject of more general interest to mechanical engineers, and about which there is such a diversity of opinion, as there is about the merits and demerits of water-tube boilers. At the recent meeting of the British Institution of Naval Architects a number of elaborate papers and much discussion was devoted to water-tube boilers, and revealed, what was known before, that persons with opportunities for getting information with reference thereto held very diverse and contradictory opinions. At this meeting, in one of the papers—by Mr. Howden—the author went on to record the various failures of water-tube boilers at sea—much more numerous than is generally known—and then proceeded to dwell on the merits of the cylindrical boiler." This form of boiler, the author said, "has been used for thirty years of uniform, unrivalled and continuing success, for every usable or practicable steam pressure yet required in sea-going steamers, and is still rising in efficiency, and was introduced on account of the failure of the water-tube, sectional and all other forms and types of boilers to supply sea-going steamers with high-pressure steam safely, easily and economically."

The writer of that paper then went on to compare the power, weight and space occupied by Belleville water-tube boilers in the steamers *Polynésian* and *Armand Behic* with the same function and features of cylindrical boilers capable of working continuously at the highest power attained by the Belleville boilers. These latter, we are told, on trial attained 8,000 indicated H.P., while their average working power at sea was 5,000 indicated H.P. They occupied 980 sq. ft. of floor space in the ship, and weighed, including water and all mountings and funnel, 380 tons. These particulars were then compared with those of cylindrical boilers capable of working continuously at the highest power attained by the Belleville boilers on trial—that is, 8,000 indicated H.P.—and also of working with ease and economy at the sea power of 5,000 indicated H.P., but which can be worked as high as 6,000 indicated H.P. when required. They occupied 877.5 sq. ft. of floor space, or 102.5 sq. ft. less than the Belleville boilers. The weight of the cylindrical boilers, including the fans and engines and all forced draft apparatus, water, funnel, and all mountings, as in the water-tube installation, was 361 tons, or 19 tons less than the Belleville boilers. The author of the paper pointed out that the quantity of water in the latter would probably not be more than one-third of that in the cylindrical boiler. He then criticised the feed-water arrangements and said: "These twenty water-tube boilers would require for continuous work at sea 20 men constantly engaged in regulating the feed supply; and even then the feed-water and steam pressure, and consequently the revolutions of the engines, would fluctuate greatly—a most objectionable result. The two cylindrical boilers, on the contrary, would only require the occasional attention of the engineer of the watch in the charge

of the machinery generally or his assistant. The large quantity of water acts as a storage of power, like the fly-wheel of an engine, and prevents rapid fluctuations, and gives ample time to call into action the reserve-feed pumps, or take other necessary precautions should any accident happen to the ordinary supply."

On the other side of the question, Mr. Thorneycroft, of torpedo-boat fame, read a paper in which he compared the water-tube boilers of his construction, which have been put into the third-class cruiser *Geiser*, with locomotive boilers which were put into the sister ship *Hecla*. "In the case of the *Geiser*," he says, "an equal power was given to that obtained in the sister ship *Hecla* with locomotive boilers, *but with a reduction of some sixty tons.*" He then went on to call attention to what his firm undertook to do in the case of the *Speedy*. In this vessel they had guaranteed to give 1,000 more H.P. than with the locomotive boilers in sister vessels, "*and with a considerable less weight of boilers.*" A tabular statement is then given from which the following data are taken: Indicated H.P. of locomotive boilers, 3,500; weight of boilers and mountings, dry, 82 tons; weight of water in boilers, 30 tons: total, 112 tons. Indicated H.P. of Thorneycroft water-tube boilers, 4,500; weight of boilers and mountings, dry, 79.74 tons; weight of water in boilers, 12.78 tons; total, 92.52 tons. The total weight per H.P. of the locomotive boilers is thus 71.6 lbs. and of the water-tube boilers, 46 lbs. The quantity of water in the boilers was, however, only 6.36 lbs. in the Thorneycroft boilers and 19.2 lbs. in the others. It is, therefore, perhaps not remarkable that, as Mr. Thorneycroft says, there was some difficulty encountered in feeding these boilers with sufficient regularity. Continuing, he said that "the system of feeding which was employed, and which was perfectly efficient for boilers holding large volumes of water, seems to require some modifications in the case of water-tube boilers, where the water contained is relatively very small for the rate of evaporation; and he had come to the conclusion that some form of automatic control is desirable." He also admitted that small quantities of grease in the boiler had disastrous effects. This admission of Mr. Thorneycroft would seem to be in a measure confirmatory of the charges of Mr. Howden; but to add to the doubt which any one seeking information on this subject must feel with reference to the whole subject, another speaker, Mr. Saxton, of Messrs. Maudslay, who took part in the succeeding discussion, commenting on that portion of Mr. Howden's paper in which it was asserted that 20 boilers would require 20 water tenders, said: "He had some experience in the French mail steamer *Normandie*, fitted with Belleville boilers. In the *Normandie* one man did the work of Mr. Howden's 20, and he was an Arab. As a matter of fact, the boilers had an automatic feed, which took care of itself; but if it did not, it made very little difference to the boilers. The last thing the engineers in the ship thought about was the water level. Many of the boilers in the ship had no glasses in the gauge fittings. In testing a Russian ship with a Belleville boiler, the gauge glasses broke early in the day; he wanted them replaced at once; but the engineer in charge only laughed, and a highly successful trial was made without them."

Mr. Yarrow also read a paper on this subject, in which he said that "In H. M. S. *Havock* they adopted two locomotive boilers, and indicated on trial about 3,500 H.P. with an air pressure of 3 in. In the *Hornet*, which is a sister ship, provided with similar engines and fitted with eight water-tube boilers, as previously described, they obtained with a very low air pressure, averaging 1¼ in., 4,300 H.P. The eight boilers in the *Hornet* weighed 11 tons less than the locomotive boilers in the *Havock*. They had every reason to fear, from what they were told, that trouble would be experienced in working this group of small, rapidly evaporating boilers in the *Hornet;* but, as a matter of fact, they had experienced no difficulty whatever, the feed being arranged in, as it were, two stages. The feed pumps on the engines take their suction from the hot well, and deliver into a reservoir at 50 lbs. pressure, and from this the donkeys take their suction, each boiler being provided with an independent pump."

The discussion at the meeting, from the proceedings* of which we have quoted so liberally, indicates very distinctly that the water-tube boiler has come to stay. It has had a struggle for existence during its infancy, and the evolutionary process of the survival of the fittest is not yet ended; but the young leviathan is now too vigorous and is capable of doing so much good work that there is no probability that its kind will ever become extinct.

The makers and inventors of water-tube boilers apparently do not realize at its true value the importance of having a large volume of water relatively to the working capacity of the boiler. This has been demonstrated a thousand times in locomotive practice. As every one knows, the first locomotives were small, insignificant machines of a few tons' weight. Their size has been constantly increased until now we have the magnificent structures which weigh many tons instead of a few. During this process of growth the little machines have been constantly obliged to do more work than they were designed for, and their boilers have had to be forced to their utmost capacity. Now it has been a very common experience that boilers with a small water capacity always work unsatisfactorily when forced to do their utmost. As Mr. Howden pointed out, "the large quantity of water acts as a storage of power, like the fly-wheel of an engine, and prevents rapid fluctuations."

Some experience twenty-five years ago illustrated this. As all the participants in that experience are now dead excepting the writer, there is no impropriety in mentioning names. The Grant Locomotive Works, then located at Paterson, N. J., built some American type of locomotives for the Chicago, Burlington & Quincy Railroad, which had what are called straight-top boilers with barrels whose dimensions are now forgotten, but which were comparatively small. These engines were sent to Illinois and put on the road, and the Superintendent of Motive Power reported that they would not do the work they were intended for. The writer was sent out to investigate, and, if need be, subject them to a test. Mr. C. F. Jauriet was then at the head of the Machinery Department of that road. He referred to some engines which he had built and altered, and which, he said, were doing more work than those from the Grant Works. It was finally agreed to make a test of the two classes of engines. This was done on freight trains between Chicago and Aurora, Ill., with the result that the Grant engines were badly beaten. The facts were, though, that the Jauriet engines had boilers of considerably larger diameter and had a high "wagon-top" over the fire-box, which was widened out, thus giving considerably more water capacity both in the barrel and around the fire-box. As Jauriet expressed it, this enabled him to "bottle up the power." In the Grant engines great care had to be taken in carrying water, otherwise the boiler would "work water," whereas the other boiler could be pumped up so as to nearly fill the barrel, the wagon-top giving ample steam space. The engineers of these engines were not slow to avail themselves of this advantage, and on approaching the grades, which abound between Chicago and Aurora, would fill the boiler as full as they could, fire up and get it hot, and at the critical point, with a heavy train, if there was danger of losing steam, would shut off the feed and work over the hard place with their "bottled-up" reserve power, whereas the Grant engine had no such reserve to fall back on if the boiler did not make enough steam.

It is true that a marine boiler does not work under condi-

* Our quotations are from the columns of *The Engineer*.

tions which vary within such wide limits as a locomotive boiler must, but the disturbing influence of the rolling and pitching of a ship is greater than the motion of a locomotive, and "bottled-up" power is always a good thing to have at sea and on a railroad and elsewhere.

If at the discussion at the Mechanical Engineers meeting on the 9th the data could be submitted, from which a comparison would be possible, of the water capacity of different classes of locomotive, cylindrical and water-tube boilers relatively to their H.P., it would be both interesting and instructive.

NEW PUBLICATIONS.

PECK'S EXPORT PURCHASE INDEX. The first number of this publication, dated April 1, has been received. It contains 126 pp. 9½ × 13 in., printed on coated paper with excellent typography and good taste. Its scope is stated to be that of a "trade exponent, covering the entire field of United States exports." It is proposed to give: 1. A list of manufacturers whose goods are indorsed as satisfactory to foreign trade. 2. An educational department, written by resident agents and commercial travelers in foreign countries. 3. Illustrations and descriptions of materials used in construction, with extracts from manufacturers' catalogues. These dedepartments will be supplemented by the "confidential discounts" of the publishers, which will be "followed up with active and energetic solicitation on the part of the publishers, resident agents and foreign salesmen."

The publication is apparently intended to be the "organ" of Messrs. William E. Peck & Co., exporters, of New York.

SURVEYING AND SURVEYING INSTRUMENTS. By G. A. T. Middleton. Macmillan & Co., London and New York. 116 pp., 5 × 7½ in.

This book was evidently not written with any knowledge of the methods of surveying that obtain in this country. Indeed, it does not appear that the author has had any particular practical surveying experience, for, on examination of his titles displayed on the title-page, he introduces himself as a member of two associations of architects and as the author of two books relating to building. There is very little contained in this volume that is of any value to an American surveyor; the methods of making surveys are crude and obsolete, and some of its directions positively bad practice—as, for instance, its condemnation of longer offsets than one chain's length for fear of inaccurately forming a right angle from the base line, and even deprecating the use of any instruments for the more correctly erecting a long offset. The preference given to the making of a land survey by a series of triangles, each side of which should be measured with a Gunter chain of 66 ft., and the use of no instrument for the measurement of angles is bad teaching; but when the author explains his preference for the Gunter chain of 66 ft. with 100 links of 7.92 in. each, over the 100-ft. chain with 100 links, because each 66-ft. length is an eightieth of a mile, and because the 100-ft. chain "is heavy to drag," he becomes amusing. It would not be surprising if the American 100-ft. steel chain is found to be lighter than the bulky English larger guage iron wire 66-ft. Gunter chain.

A very valuable bit of information to young surveyors is that given on page 2 as the "best way" to range a line in over poles—namely, "to stand against one of the extreme poles, so that the nose is flattened against it, while one eye sees past each side of it, by which means that pole is lost sight of and the distant one only seen." Can it be that to this practice we may attribute the large proportion of red noses found ornamenting English surveyors of long experience?

With all the rudimentary instructions as to the conduct of a survey, down to the recommendation to unstrap the chain before throwing it out, the author gives no directions for leveling up or "breaking" a chain in measuring up or down sloping ground. Possibly the author did not know of the necessity of this if accuracy is desired. Two young men were found recently who had received C.E. degrees from one of the leading New York colleges, who deliberately chain up a 30° slope without "breaking chain."

Among the instruments described in the volume but few are in common use in the United States. Altogether, we do not find that this book covers any field that is not already very much better covered by a number of books treating the same subjects by other authors. It is really saddening to a lover of books to see good paper and ink thrown away recklessly in this way. It might be suggested to the author, "Schuster, bleib bei deinem Leisten."

TRADE CATALOGUES.

ANTI-FRICTION, OR BABBITT METAL. National Lead Company, No. 1 Broadway, New York. 8 pp., 3¼ × 6 in. This is a very small treatise on anti-friction metal, and is designed to show the superiority of the Babbitt Metal manufactured by this company.

HAND-POWER TRAVELING CRANES. Meavis & Beekley, Philadelphia. 8 pp. 5½ × 8 in. This is a modest little pamphlet describing the traveling cranes manufactured by this firm. It contains an engraving representing one of their crane structures, a description thereof, and tables of the sizes manufactured, which range from two to ten tons capacity, and spans up to 36 ft.

THE CHARTER GAS-ENGINE COMPANY, Sterling, Ill. Last month we criticised a catalogue issued by this company, and suggested that a fuller description of their engines would add to the interest and usefulness of the publication. Since then we have received another edition of it which contains a good engraving of the engine, with explanatory references printed in it in red ink, which, with the description, make the construction quite clear. It is still thought, though, that with the aid of a sectional representation of the engine, and letters of reference, an explanation could be given which the wayfaring man and editors of papers could understand easier than they can a description without such illustrations.

MACHINE TOOLS FOR THE RAPID PRODUCTION OF LATHE WORK. The Lodge & Shipley Machine Tool Co. Cincinnati, O. 43 pp. 3¼ × 5¼ in.

In the preface to this little pamphlet the publishers say very truly that "much thought has been expended on the rapid production of all work manufactured by the screw machine." It is then announced that they manufacture such machinery, and their catalogue is devoted to a description thereof. It is illustrated with small engravings of a 30-in. double-saddle turret lathe, a 60-in. pulley lathe, a pulley drilling and tapping machine, a 37-in. turret lathe, a 22-in. turret chucking lathe, a Fox monitor, a plain or back grand turret lathe, a horizontal and cylinder-boring machine (bores 18 in. in diameter × 3 ft. 6 in. long), a triple-facing machine, and a universal brass worker. Good descriptions of each of these machines are appended to the engravings. This publication is very convenient for carrying in the pocket; but the engravings are most too small to do justice to the machines they represent. Evidently this company has been giving much study to the production of machine tools to do work economically.

THE CHASE-KIRCHNER AERODROMIC SYSTEM OF TRANSPORTATION.

We have received a very well-printed pamphlet, describing what is called the "Coming Railroad." Briefly described, it is a somewhat remarkable elevated railroad, the vehicles of which are hung below the axles of the carrying wheels. These vehicles each have a system of aeroplanes on top, which are expected to sustain a part or the whole of the weight of the vehicles at high speeds. The scheme is not worthy of serious criticism. Lieutenant G. N. Chase, of the United States Army, and H. W. Kirchner, F.A.I.A.—whatever these letters may mean—are apparently the authors of the pamphlet and of the "Aerodromic System," which hails from St. Louis. When a machine, such as a steam-engine or type-writer, don't work right, we send it to a shop for repairs. There ought to be some analogous place to which inventors, whose heads don't work right, could have the logical faculty restored to them.

HEALD & SISCO CENTRIFUGAL PUMPING MACHINERY. Morris Machine Works, Baldwinsville, N. Y. 32 pp. 6⅝ × 10¼ in.

In the last number of the AMERICAN ENGINEER we noticed a descriptive circular and price-list issued by this company. Since then we have received from the same source a larger illustrated catalogue, which represents more fully the work done by these parties. The typography, engraving and printing of this are all excellent. There are wood engravings showing the Improved Double-suction Pumps, Vertical Pumps, Standard Horizontal Right-hand Pump (two engravings), Pump Wing and Pistons, Steam Pumps (two engravings), Standard Side-section Steam Pump, Improved Double-suction Steam Pump, Improved Hydraulic Dredging Pump, XL Ejector, Flap Valves, Foot Valves, Suction Hose, and Suction and Discharge Pipe. Besides these illustrations there are a number of diagrams made from drawings showing the posi-

tion, dimensions, etc., of the different classes of pumps. Tolerably full descriptions and tables accompany these engravings, and give an excellent idea of the kind of machinery manufactured by this company.

THE WESTINGHOUSE AUTOMATIC BRAKE CATALOGUE. Second Edition. 78 pp., 9 × 12 in.

This is a new edition of the former publication issued by the Westinghouse Air Brake Company, of Pittsburgh, to take the place of the 1890 issue, and illustrates the latest and most modern brake appliances as they have been practically developed. It is intended for the use of such railway employés as have occasion to order air-brake supplies, and will be sent to such persons on application.

Like all the publications issued by this company, it is magnificent in typography, engraving, and in its general conception. It would be difficult to find anywhere an engraving which is more comprehensive in the illustration of the organs and details, more lucid in the exposition of the functions of a complex mechanism, or more artistic in execution than the large folded plate showing all the parts of the brake apparatus. It is printed throughout on heavy coated paper, which brings out all the effect of the engraving, but it is to be feared will not stand the wear and tear of folding. All the other engravings are excellent, and have been drawn with reference to the purpose of the book, which is to facilitate the ordering of parts of the brake apparatus. Some new designs are to be found in the book—as, for example, the new 9½-in. improved air pump, on page 6. Some diagrams are also given which are intended as guides to persons ordering driving-wheel brakes for locomotives. The volume ends with the "Conditions under which Air Brake and Train Signaling Apparatus is Sold."

FULL INFORMATION FOR THE ERECTION AND USE OF THE BAKER CAR HEATERS. Revised Edition. By William C. Baker, 143 Liberty Street, New York. 42 pp. 4⅝ × 8 in.

The purpose of this book is expressed in its title. It is literally "*full*" information. It may be said of Mr. Baker, or the author of the "Information," whoever he is, as Herbert Spencer said of Tyndall: "He is an excellent expositor;" and this, Spencer goes on to say, "implies much constructive imagination." All that we have room to say here is that the directions given are very full, very clear, and easily understood. Explicitness is carried to the extent of giving engravings—and very good ones, too—one of a piece of "the largest size coal to be used in the heaters," and another showing a piece of the "smallest size."

Interspersed through the book are a number of apothegms—usually printed in italics—which it is a public benefit to impress on the minds of railroad men. The following are examples: "*Pure air is as essential to the comfort of the passengers as is warm air. There is no need of consuming more coal than is required. You cannot adapt the weather to the fire. Never go away*" (it should have been added, *nor go to sleep*) "*and leave the draft full on the fire. Never let the fire go out. Never take the water from the heater nor the heater from the car. Have it always ready for service.*" The following final injunction, it is hoped, will be generally observed: "*Simply obey all the rules, and mind all the advice given in this little book.*" Mr. Baker should have added: "Fear God, and keep His commandments; for this is the whole duty of man."

THE NEW PATENT BILL.

Provisions to Protect Innocent Purchasers and Inventors.

THE bill amending the patent laws in various particulars recently agreed on by a sub-committee of the House committee on patents has been printed, and will probably be laid before the full committee at its next meeting. The measure contains provisions for the protection of innocent purchasers of patents and limits to one year the time within which applications for patents on articles already patented abroad must be made in this country. The section for the protection of innocent purchasers of patents provides that whenever a patent is alleged to be infringed, the patentee shall seek his remedy by bringing suit in the first instance against the manufacturer or vendor of the article alleged to infringe said patent, and that in no case shall an action be maintained against any individual who shall have purchased, in good faith, a patented article of a regular dealer in the open market for his own use, or who shall innocently use the same for agricultural or domestic purposes, until after such patent has been sustained by a decree of a court of competent jurisdiction, nor unless such purchaser shall fail or refuse to give to the patentee or his representative, at his request, the name and residence, if known to such purchaser, of the party from whom he purchased the patented article.

An important amendment carried by the bill reduces from two years to six months the time in which all applications for patents filed shall be completed and prepared for examination. Upon the failure of the applicant to prosecute the same within six months after any action thereon, they shall be regarded as abandoned by the parties thereto, unless the delay was unavoidable.

INTERNATIONAL STANDARDS FOR THE ANALYSIS OF IRON AND STEEL.

THE Sub-Committee on Methods for the Analysis of Iron and Steel have sent the following bulletin to the iron and steel chemists of the country, so far as they could get their names. They earnestly request that any who do not receive a copy of the circular, but who do see this, will comply with the request of the bulletin the same as though they had received a circular direct.

CIRCULAR TO IRON AND STEEL CHEMISTS ON METHOD OF DETERMINING PHOSPHORUS.

DEAR SIR: At the World's Congress of Chemists in Chicago a Sub-Committee of the original Committee on International Standards for the Analysis of Iron and Steel was appointed to consider the subject of Standard Methods.

This Sub-Committee consists of Dr. C. B. Dudley, Chairman; Messrs. A. A. Blair, W. P. Barba, P. W. Shimer and T. M. Drown. It has recently held a meeting and has decided to recommend standard methods in iron and steel analysis to be used as the basis of commercial transactions. The Sub-Committee fully appreciates the fact that these methods, to have the highest value, should be in facility and in time of execution such that they will readily recommend themselves for daily use in iron and steel works.

To further this end the Sub-Committee wishes to have the co-operation of the iron and steel chemists of the country, and to ask them for a brief outline of the processes or methods they use and prefer for the determination of different elements in iron and steel, and for such other information and suggestions as they think will aid it in the work before it. The Sub-Committee recognizes the fact that it will add immensely to its efficiency and value if the iron and steel analysts of the country will take a personal interest in it, and aid it by their counsel and active influence.

You are therefore requested to send to the Chairman of the Sub-Committee, as soon as convenient, such an outline as you may deem sufficient to fully describe your practice. It is suggested that you follow the general plan here indicated, by answering the following questions, which may be referred to by number to save you unnecessary trouble.

1. What general method do you use for the determination of phosphorus in iron and steel?
2. What special precautions do you consider necessary to make this method reliable?
3. What precautions do you take to prevent the interference of arsenic?
4. What factors do you use in your calculations?
5. What variations do you introduce in the case of iron ores or slags?
6. Do you use the same method in pig iron and steel and do you consider the results equally reliable?
7. Do you ever examine the residues insoluble in acid, in pig irons, or iron ores and do you ever find phosphorus in them?
8. Are all your determinations made by the same method, or do you check your work by reference to another method, and if so, what method do you use for this purpose?
9. How many determinations do you make a day in your laboratory under ordinary circumstances?
10. What do you consider the greatest length of time necessary to obtain a result, permissible in your work?

The Sub-Committee begs that you will send at the earliest possible moment as full replies to all or any of the above questions as you conveniently can, and assures you that in making use of any details that may be original with you, you shall have full credit. You will likewise be furnished with copies of the various reports.

CHARLES B. DUDLEY,
Chairman Sub-Committee,
ALTOONA, PA.

APPROVED,
J. W. LANGLEY,
Chairman Com. on Int. Standards.

PERFORMANCE OF ENGINE 870 ON THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

The following very remarkable performance of this engine will interest many master mechanics and locomotive engineers. Who can beat it?

ON EMPIRE STATE EXPRESS TRAIN, RUNNING NORTH; ON SOUTHWESTERN LIMITED TRAIN, RUNNING SOUTH.

Out of the shop	March 26th, 1893
In the shop	April 2d, 1894
Period out of the shop	370 days
Idle	10 "
Continuous service	360 days
Made 360 round trips between New York and Albany.	
Mileage during that period	105,866 miles
Cut out on April 5th, 1893, for broken follower bolt	10 minutes
Cut out February 6th, 1894, whistle broken	30 "
Total time lost by reason of engine failures	40 minutes
No other engine failures.	
Time lost other than engine failures	21 h. 57 m.
Made up exceeding schedule time	39 " 51 "
Total time made up exceeding schedule time and time lost	17 h. 14 m.

NOTES AND NEWS.

Liverpool Station in London.—The enlargement of the Liverpool Station in London is proceeding rapidly, and when completed, it is claimed that it will be the largest station in that country. It will have 18 platforms and 20 lines. At the narrowest part of the approach there will be 6 lines, and with the new signal arrangements and short blocks, it will be possible to run trains in or out every 2 minutes. At present between 700 and 800 trains are run in and out daily; but the enlargement will enable the company to operate 1,000 trains a day.

Railroad Through the Sea.—An interesting experiment is about to be carried out at Brighton, Eng. A marine railway will connect Brighton with the little village of Rottondon. The rails will be laid on solid rock with a car, and at high water will be covered with the sea, which, however, will not affect the carriages, as the latter are to be supported on framework raising them above the level of the water. At this part of the coast the cliffs are high and the beach inaccessible, so that no boating will be interfered with. The cars are to be moved by electricity.

Swiss Cable Railways.—The last of the Swiss mountain railroads is that up the Stanserhorn, which rises 6,235 ft. above sea level, a little south of Lake Lucerne, not very far from the Pilatus and the two Rigi railroads. It is a cable road, or, rather, three cable roads, each with two cars, a motor at the upper end, and an automatic turnout in the middle. The passengers change cars at the end of each line. It can carry 32 persons every 16 or 17 minutes, and, including the changes of passengers, the time required to reach the summit is 54 minutes. The fare for the round trip is $1.55. The first section is 1,585 m. long, and rises 276·7 m.; the second section, 1,082 m. long, rises 508.4 m., and the third, 1,270 m. long, rises 627.8 m. The grades of the first section vary from 422 ft. to 1,452 ft. per mile; of the second and third, from 2,112 ft. to 3,273 ft. per mile. A contemporary says the braking is effected from the motor stations, and is novel—peculiarly formed rails being required for it. The motive power is electricity, generated at each motor station by water power.—*Engineering.*

German Process of Drying Wood.—A German process for drying woods has been tried, and with some success, by a firm of Canadian lumbermen. It consists briefly in placing the timber for 12 days in chambers heated by steam and then in another room to dry. The plan, it is said, entirely gets rid of sap, and has been found more efficacious with juicy woods like beech and birch. It is certainly the case that timber prepared by this means is largely used in Germany, and particularly in Bavaria. At the same time it is stated that this artificial seasoning is not nearly so efficacious as that produced by natural means. Woods thus forced into maturity are apt later on both to warp and to rot. The constructors of the German navy have altogether declined to use wood so prepared, though it has been found useful for fencing and other kinds of cheap carpentry.—*Manchester Courier.*

Aerial Railway at Gibraltar.—A cable railway has recently been erected at the rock of Gibraltar, carrying a suspended car, in which all kinds of materials are transferred to the summit of the rock. The time required is about five minutes. At the north end of the Alameda is an engine house from which two cables rise with a stretch of 300 yds. as far as the edge of the cliff. Above this point the convex shape of the rock necessitated their being raised from the required height of the ground by means of trusses. The cables are constructed with a capacity of 70 tons, but the strain upon them is never allowed to exceed six.

Armor Plates in the British Navy.—The following is from a report emanating from official sources: The past year has been remarkable for the results obtained from experiments conducted with steel armor treated by the "Harvey" process. Armor plates supplied by four firms have been tested, by and for the Admiralty. The investigation has been most thorough and extensive, and, as a result, orders have been given for Harveyed steel armor for the *Renown*, *Majestic*, and *Magnificent*. In the course of the experiments the use of nickel as an alloy of steel for the purposes of armor-plates has been fully tested. It has been established that Harveyed plates without nickel in the steel show resistance to modern projectiles as great as any hitherto obtained when nickel was combined with steel in plates also treated by the Harvey process. The consequence of adopting this new system will be a great saving in cost for a given defense. By means of these improvements the power of defense obtainable with certain thicknesses and weights of armor has been very greatly increased, and this circumstance must considerably affect the designs of battleships to be laid down in the future.

German Locomotives.—Mr. G. Lentz, in a recent address before a German engineering society on locomotive design, said that the German and other continental locomotives are modeled after both English and American designs, with the result that a mixture of the features of both is found in them; the practice of later years, however, following rather more closely the lines of English builders. But the inside cylinders and crank-axles of the English engine have not found favor, at least not in Germany, where sharper curves are permitted than in England, and where, therefore, numerous crank-axle failures have led to the adoption of outside cylinders. Compared with the English locomotive, the American engine does not commend itself in appearance to Mr. Lentz's tastes; there being, as he puts it, less beauty of design in its make-up, while in many cases it is embellished with flourishes and needless ornamentation which give it an unrestful air. The English builder, on the other hand, aims at the utmost simplicity, and turns out an engine solid and clean cut in appearance. Next to the English engines in the order of merit, so far as appearance is concerned, Mr. Lentz places those of Belgian make, in which inside cylinders largely prevail. Crank-axle fractures, however, occur in large numbers with these, notwithstanding the fact that their design provides for an extra bearing for these axles.

Boilers and Machinery in the British Navy.—The following extracts from a report show the progress which is being made in the British Navy in the use of water-tube boilers: During the year 1893–94 a large number of ships have passed satisfactorily through their contract steam trials. They included eight battleships, six first-class cruisers, three second-class cruisers, eight torpedo gunboats, and the torpedo-boat destroyer *Havock*. The *Devastation* has been re-engined and fitted with boilers of the common combustion chamber type. The tubes being fitted with the Admiralty cap ferrules enabled the trials to be accomplished satisfactorily. The fitting of these ferrules has been extended in the boilers of her Majesty's ships with satisfactory results. In connection with the propelling apparatus of the *Powerful* and *Terrible* it became necessary to decide whether, in view of the very high sea-speed for which the vessels are designed, and the great power required for the attainment of that speed, a new departure should not be made, and boilers on the "water-tube" principle adopted. After full inquiry into the experience gained in recent years with water-tube boilers fitted in sea-going ships, it was decided to adopt a type which has proved successful on a large scale and over long voyages. These boilers will be made in this country, and the orders for the machinery have been placed with two of the most eminent private firms, whose competency for the task they have undertaken is undoubted. The *Speedy* is the first ship in the Navy fitted with a group of water-tube boilers. They are of the Thorneycroft type, and with engines

by Messrs. Thorneycroft & Co. She accomplished over 4,700 indicated H.P., the contract being 4,500. Water-tube boilers of English design and manufacture, have been or are being fitted in a number of torpedo-boat destroyers now in course of construction, and those that have been tested have given most promising results. The torpedo-boat destroyer *Hornet*, engined by Messrs. Yarrow & Co., is fitted with a set of the Yarrow patent water-tube boilers, and her preliminary trials have given very promising results, her speed having exceeded that of the sister vessel, the *Havock*, the first of her class which is fitted with locomotive boilers.

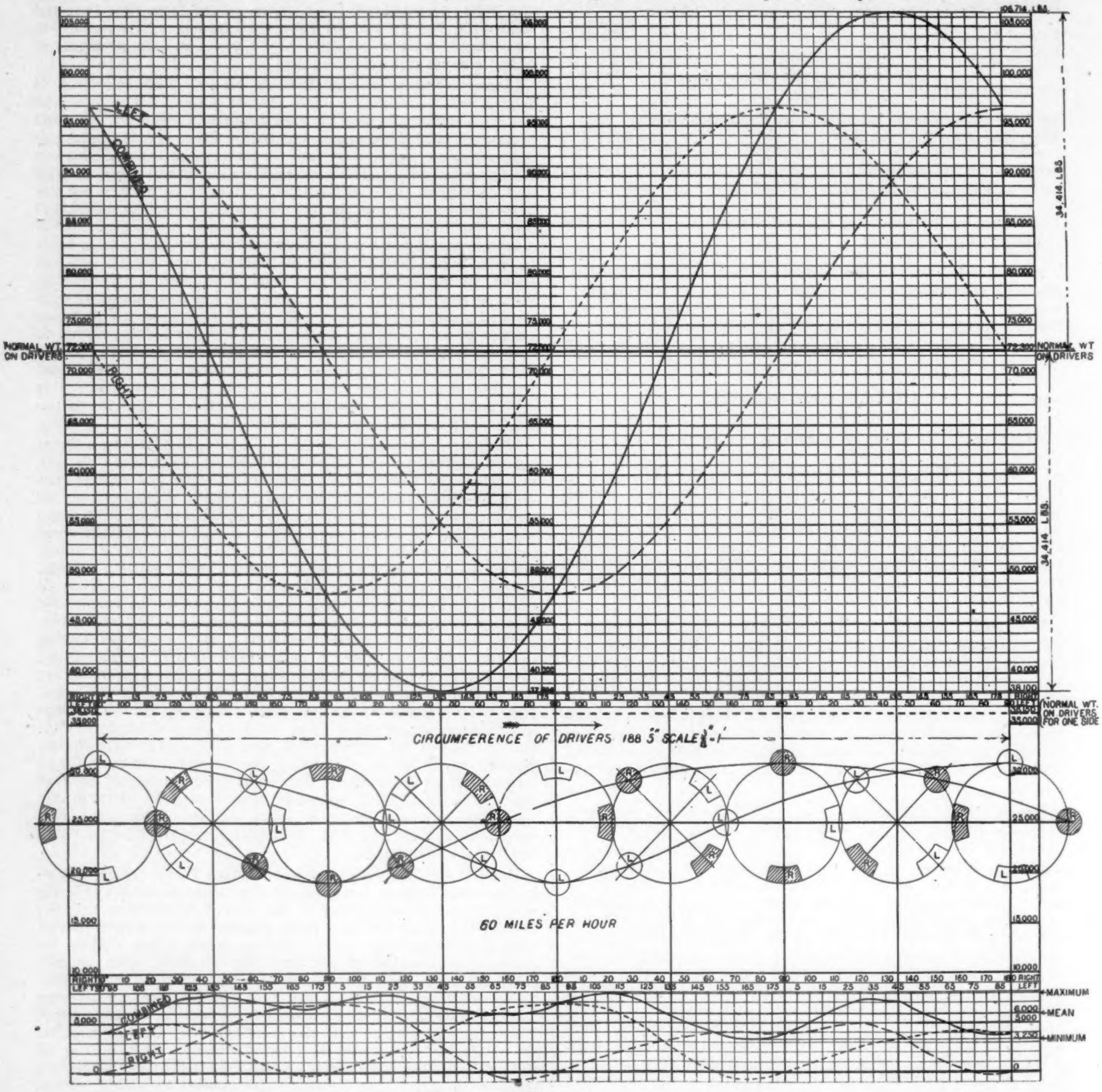


Fig. 1.

THE RECIPROCATING PARTS OF A LOCOMOTIVE.

By F. J. Cole, Mechanical Engineer, Baltimore & Ohio Railroad.

There has lately been a marked revival of interest in the counterbalancing of locomotive driving-wheels, caused largely by the higher speeds now in vogue, the increased weight of the reciprocating parts (especially in compound engines), due to the large cylinders required for the powerful locomotives at present employed in the economical operation of railroads, and the recent laboratory tests made at the Purdue University.

The object of this paper is to represent graphically the action of one or more driving-wheels during an entire revolution, at different speeds and under different conditions in a series of diagrams, arranged to show at a glance the vertical influence of the extra counterweight used to overcome the action of the reciprocating parts, and the effect of these parts to equalize the pressure on the crank-pin.

It is not claimed that any new facts will be offered, nor that the matter here presented will particularly interest those who have made a comprehensive study of the subject, but is rather designed to show it in a pictorial way, somewhat in the manner a sketch or drawing would illustrate some object one had in mind.

The effect on the track of a rapidly revolving, unbalanced wheel to increase or diminish the static weight borne by the drivers of locomotives can be readily calculated by means of the usual formulæ for centrifugal force. At the risk of seeming to repeat and reproduce here much that can be found in works on the steam-engine and physics, it is thought best to make a full explanation of the subject.

The word centrifugal is derived from Latin, *centum*, a center; and *fugere*, to flee; and is defined as "that force by which a body moving in a curve tends to fly off from the axis of motion in a tangent to the periphery of the curve." It is

best understood in the simplest form as the tendency to break a string, to one end of which a weight is tied revolving around in a circle. It equals in pounds one-thirty-second part of the weight of the rotating mass multiplied by the square of the velocity in feet per second, with which the center of gravity of the weight moves in its path, and divided by the radius, in feet, of the circle of motion of the center of gravity of the weight.

Or, expressed in revolutions per minute, the formula becomes the well-known and familiar one usually used in the calculations of governors, fly-wheels, and other parts and details of steam-engines :

$$\text{Cent. } F = W \times R^2 \times r \times .00034,$$

in which

W = weight in pounds ;
R = revolutions per minute ;
r = radius in feet.

The revolutions per minute corresponding to different speeds in miles per hour, for various diameters of driving-wheels, are giving in the following table :

Diameter of Wheel.	Miles Per Hour.						
	40.	50.	60.	70.	80.	90.	100.
Inches.	Revolutions per Minute.	Revolutions per Minute.	Revolutions perMin.	Revolutions perMin.	Revolutions perMin.	Revolutions perMin.	Revolutions perMin.
44	305.58	......	......	......	......	......	......
50	268.92	336.15	......	......	......	......	......
56	240.12	300.15	360.18	......	......	......	......
60	224.10	280.12	336.15	392.17	......	......	......
62	216.87	271.08	325.30	379.52	433.74	......	......
68	197.73	247.16	296.59	346.03	395.46	444.89	......
72	186.75	233.43	280.12	326.80	373.48	420.17	466.86
78	172.39	215.48	258.58	301.68	344.78	387.87	430.97
84	160.07	200.09	240.10	280.12	320.14	360.15	400.17
90	149.40	186.75	224.10	261.45	298.80	336.15	373.50
96	140.06	175.07	210.09	245.10	280.12	315.13	350.15

Counterweights are added to all locomotive driving-wheels to balance the total revolving weights, consisting of the crank-pin, crank-pin boss, side or parallel rod, and back end of main rod, and a portion or all of the reciprocating weights, consisting of the piston and rod, cross-head, and front end of main rod. To obtain a perfect horizontal balance, all the weight of the reciprocating parts must be balanced in the counterweight, as it is evident upon a little reflection that the centrifugal force of the weight will exactly equal and neutralize the effect of the other when they are similar.

The vertical disturbance, however, is increased in direct proportion to the extra amount added over and above the weight required to balance the revolving parts.

In view of this fact, the practice of railroads and locomotive builders generally is to vary the amount from two-thirds to the full weight, according to the style of engine, speed, and other considerations.

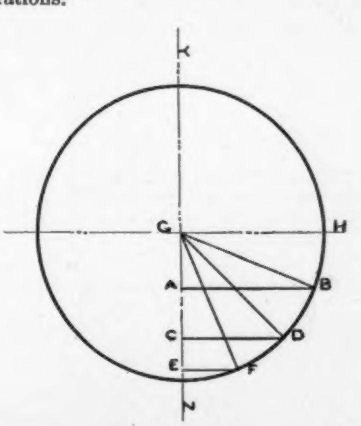


Fig. 2.

The smoothest running engines at high speeds are those fully balanced. This has been demonstrated so repeatedly on engines with varying amounts, that it now seems pretty well understood ; but on account of the excessive vertical effect on the track, caused by rapidly revolving, unbalanced wheels, it is considered by many that the minimum amount consistent with comparative freedom from excessive fore-and-aft jerking should be used.

The varying increase and decrease of the normal weight on the drivers can be quickly comprehended by means of curves plotted for given weight, speeds, etc. Fig. 1 shows the effect of reciprocating parts of an eight-wheeled engine having four coupled drivers and a four-wheeled truck.

Diameter of drivers.................	60 in.
Size of cylinders.......	18 in. × 24 in.
Weight on drivers.......	72,300 lbs.
Steam pressure............	160 lbs.

Weight of reciprocating parts :

Piston and rod............................	285 lbs.
Cross-head................................	138 "
One-half main rod........................	211 "
Total.....	634 lbs.

On the diagram the spaces between the horizontal lines represent 1,000 lbs., and each vertical line 5° of crank movement, 72 lines in all equaling 360°, or one revolution. The heavy horizontal line marked, "Normal weight on drivers," is the weight—72,300 lbs.—carried on them, plotted from the base-line.

In this diagram the weights borne by each wheel have not been considered, as the effect of each side of the engine and the combined or total effect of all drivers has been plotted. While the individual result is slightly different when plotted separately, yet the total result of one side or of both sides or all the wheels is the same. Later on the exact effect of each wheel will be considered. The speed of the engine is assumed to be 60 miles per hour. As the drivers are 60 in. in diameter, the number of revolutions per minute will be 336. The maximum increase or decrease of the normal weight on the drivers for one side will be $W \times R^2 \times r \times .00034 = 634 \times 336^2 \times 1 \times .00034 = 24,335$ lbs. Referring to the relative positions of cranks and counterweights shown toward the bottom of the diagram (on the line marked 25,000, merely for convenience, because of the blank space in the diagram), commencing on the extreme left, the counterweight for the left side is shown down at its lowest and the crank at its highest position at 90°, both marked *L*. Consequently, as the unbalanced weight tends to fly out radially from the center, the normal weight—36,150 lbs.—or load borne on the drivers when the engine is at rest will be increased by the amount of the centrifugal force—24,335 lbs.—making a total of 60,485 lbs.

The base-line for one side is the heavy, dotted, horizontal line marked 36,150. The vertical height from it to the curved lines marked right or left will be the weight on track for either side at any position of the crank.

The dotted, curved line at upper left-hand corner of diagram marked left is plotted by making the height equal 60,485 from its dotted base-line or $60,485 + 36,150 = 96,635$, from the real base-line corresponding to the marginal figures. Following out the motion of crank, from left to right, the succeeding positions for each 45° can be found by multiplying the maximum centrifugal force by the *sine* of the angle, thus : $24,335 \times 7,071 = 17,207$ lbs. $+ 36,150 = 53,357$ lbs., or if desired, the same result can be obtained by multiplying by the vertical ordinates *A, B, C, D, E, F*, on the line *Y, Z*, fig. 2, and dividing by the radius ; 53,357 is measured from the dotted base-line, or $53,357 + 36,150$ from the real base, and the position plotted on vertical line marked 135° for left crank angle.

At 180° the counterbalance exerts no vertical force, as the tendency is entirely horizontal, and is absorbed or neutralized by the reciprocating parts when they are equal in weight. This position for the curve on diagram is at 36,150 from the dotted base for one side, or 72,300 from the real base-line, consequently it is located at the intersection of the vertical line for 180° left crank angle and the heavy horizontal line marked in margin 72,300 lbs. Continuing the curve, the normal weights of engine at rest gradually diminishes as the counterbalance passes the horizontal line and approaches the upper portion of wheel. The centrifugal is exerted upward, and must be deducted from the weight on the drivers, becoming a minus quantity, precisely as it was plus during the first quarter of a revolution, followed on the diagram until the minimum is reached at the position of the crank angle marked left 90°, after the wheel has completed half a revolution. The intermediate positions for each 5° can be found in like manner, and the location plotted on the diagram, making the curved line as shown.

The curve for right side is started at 36,150 lbs.—the normal weight—90° ahead at the left, and is plotted out in exactly the same way. The two curves, then, for right and left

side, shown in dotted lines, represent the independent effect of the driving-wheels coupled together for each side. Owing to the cranks being set at 90° apart, and the counterbalances located exactly opposite thereto, it follows that when one weight is exerting its maximum effect up or down, the opposite side will be zero. The wavelike increase or decrease of weight can be readily followed on the diagram, the curved lines for each side being similar, but occupying position 90°, or one-quarter of a revolution apart horiontally, tending to resenting normal weight, and must be plotted above or below that line, as the combined effect of both curves, measured on any vertical line, becomes a minus or plus quantity.

Following this combined curve from the left to the right, it starts at 24,335 lbs. above the normal, falling to the normal at one-eighth of a revolution, because at this point the left is 17,207 plus and the right 17,207 minus; the combined effect is zero.

Advancing now to the next 45°, the curve is — 24,335 lbs.,

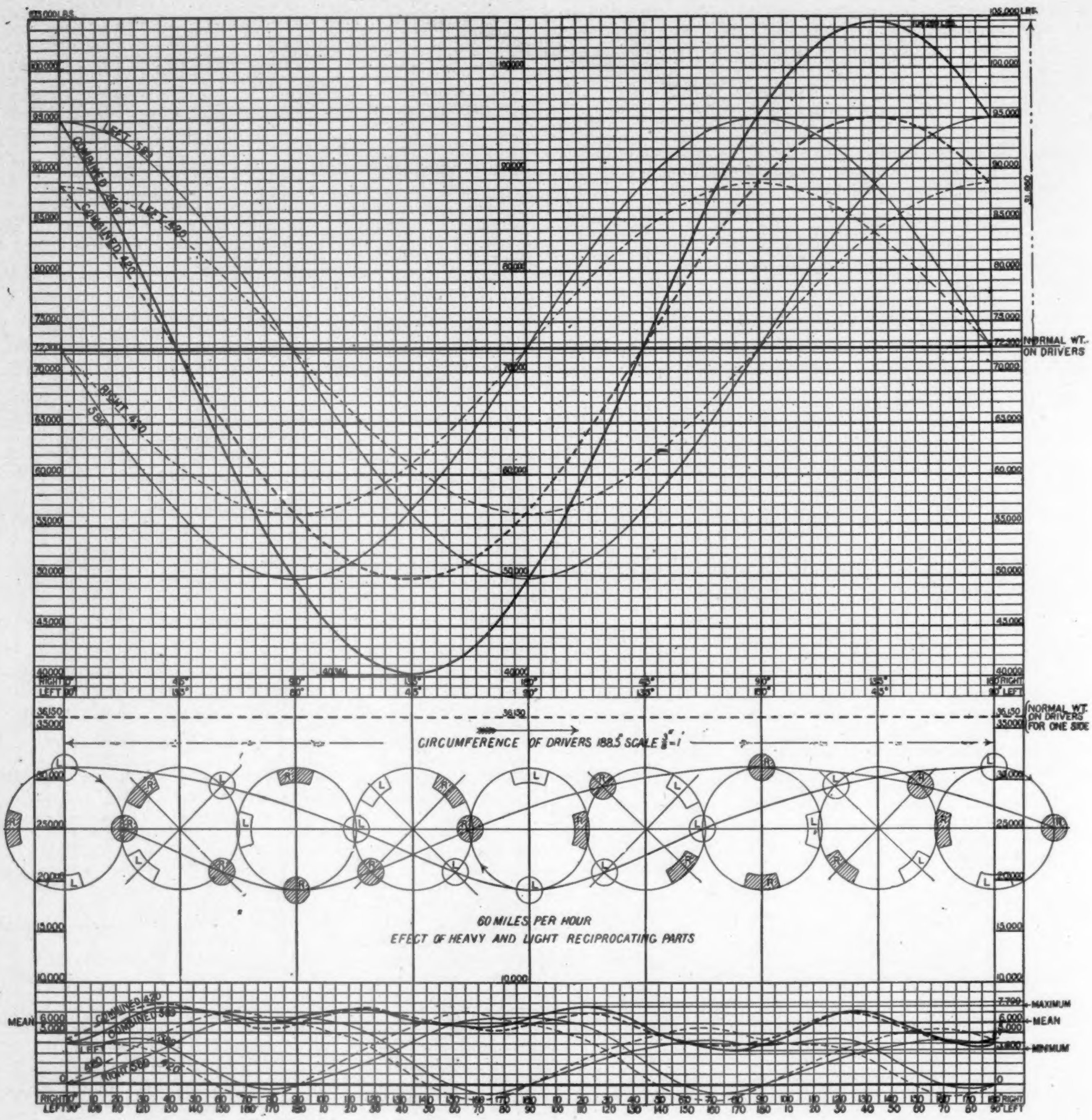


Fig. 3.

derived entirely from the right side, as the left at this position is zero.

sway the engine from side to side and swing it like an inverted pendulum.

Combining these curves, the line shown full and marked "combined" is formed. Commencing at the left of diagram, it is plotted out from the horizontal line marked 72,300 lbs. normal weight of drivers, and represents the total effect of all four drivers on the track, in a length and width of a space occupied by the driving wheel-base, similar to the floor of a track scale on which the drivers alone were being weighed.

It is formed by measuring on all the vertical lines the point of intersection of both curves for each side from the line rep-

At the next 45° the maximum decrease of weight is reached, as the effect of both cranks is the same, being — 17,207 lbs.; the combined curves is — 17,207 × 2 = 34,414 lbs.; this subtracted from 72,300 lbs., the weight on drivers at rest, leaves 37,886 lbs. as the minimum weight. Combining the curves in a similar manner for the remaining one-half revolution, it reaches the normal weight again at 90°, and the maximum in 180°; the weight is increased by a like amount—viz., 34,414 + 72,300 lbs. give 106,714 lbs. maximum.

From this combined curve the alternating increase and decrease of weight is easily followed by the eye, the diagram being figured and plotted to give it prominence.

It will be observed that the variation in weight during one-half revolution is 106,714 — 37,886 = 68,828 lbs., approaching and almost reaching the weight on the drivers when the engine is at rest.

On fig. 1, at the bottom, are shown curves representing the tractive force of the locomotive, corrected for the influence of the reciprocating parts during one revolution. These are best and most clearly shown in their relation to the weight on the drivers on the same diagram, and will be considered at length later on.

Fig. 3 represents a diagram constructed in the same manner as fig. 1, showing the effect of light and heavy reciprocating parts at 60 miles per hour. Class of engines, weights, etc., are same as considered in fig. 1, except the heavy reciprocating weights are taken at 589 lbs. instead of 634, the difference being that in the first case half the actual weight of the main

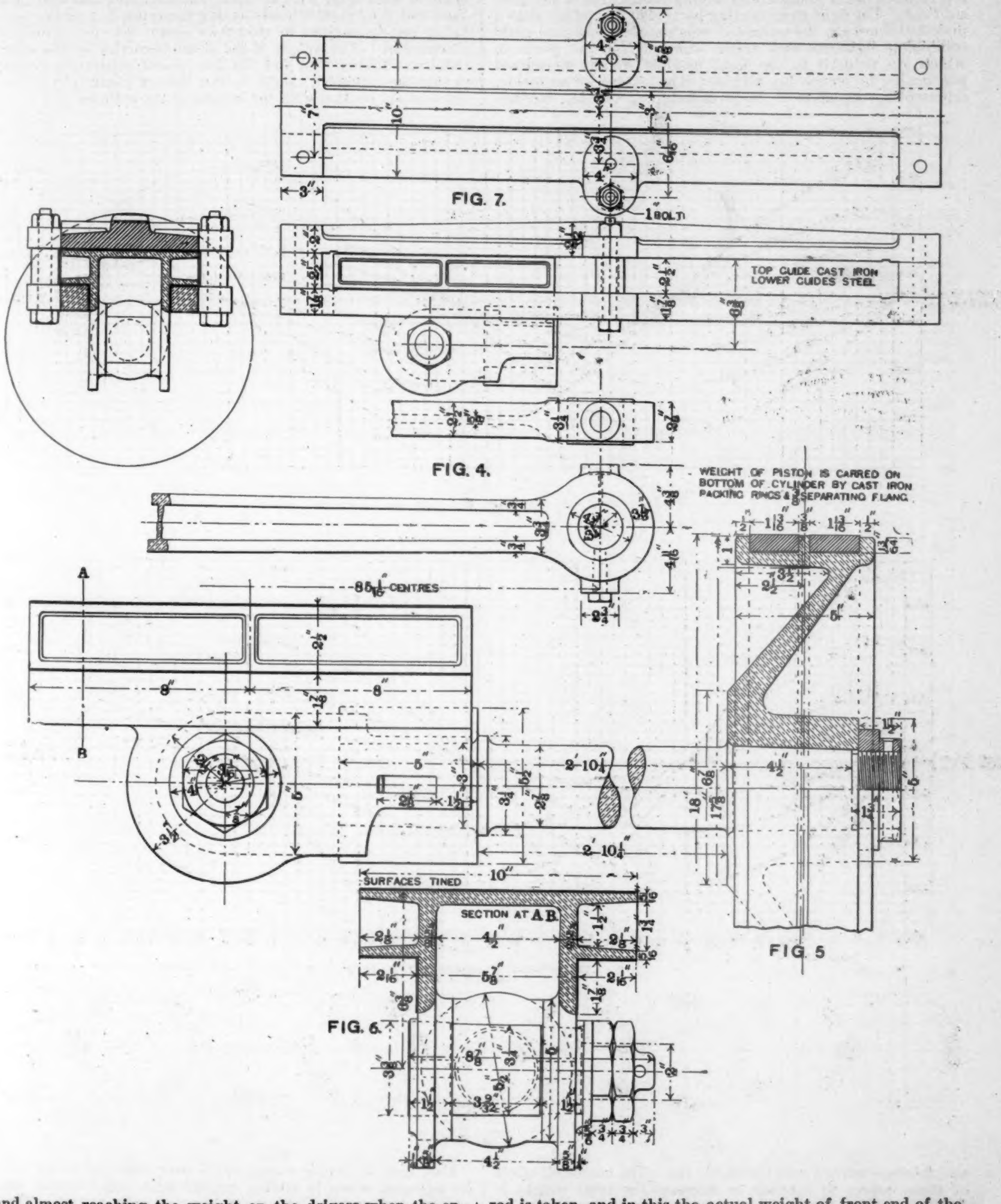


FIG. 7.

FIG. 4.

FIG. 5

FIG. 6.

rod is taken, and in this the actual weight of front end of the same, so that it would be in harmony and could be properly compared with the lighter design. The effect of the heavy parts is shown in full, curved lines, marked left 589, right 589, combined 589. Total increase of decrease of weights each side of engine, due to the heavy reciprocating parts, is 22,600 lbs. instead of 24,207, as in fig. 1. The combined effect of these curves to increase or decrease the total weight resting on the driving-wheels is 31,960 lbs., making the alternations

of weight during one-half revolution 63,920 lbs., and the actual weight on the drivers 40,340 minimum and 104,260 as maximum.

The heavy reciprocating parts (589 lbs., effect shown in full lines) are the actual weights of a class of engines that are rather lighter than the average construction. They are selected as representing good practice and average conditions at the present time. The light reciprocating parts (420 lbs., effect shown in dotted lines) are the estimated weights of re-designed parts combining lightness and ample strength for the purpose, which are reduced to the least possible weight considered practicable for every-day service. The curves for each side, representing the effect of the parts weighing 420 lbs., increase

rod, it is well known, will give satisfactory service if suitable material for bushing is used, and the wrist-pin, thoroughly hardened and ground perfectly true, and fitting neatly in bushing. The back end of the rod being merely balanced as the revolving weight is not shown. The cross-head is represented in fig. 6, made of cast steel, with an open, annular, diagonal web; the back and the cylinder-heads having corresponding projections fitting into its cavities to reduce its steam clearance spaces to a minimum. The weight of the piston is carried by the wide, cast-iron packing ring and the ⅝-in. center separating flange, so that the cast steel, except in this narrow center piece, does not come in contact with the bottom of the cylinder.

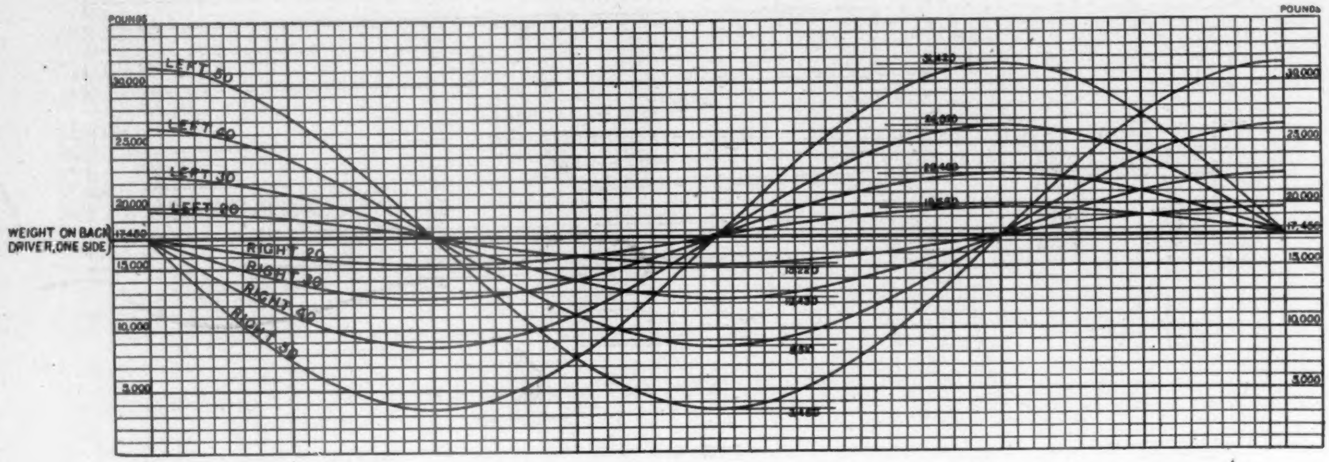


Fig. 8.

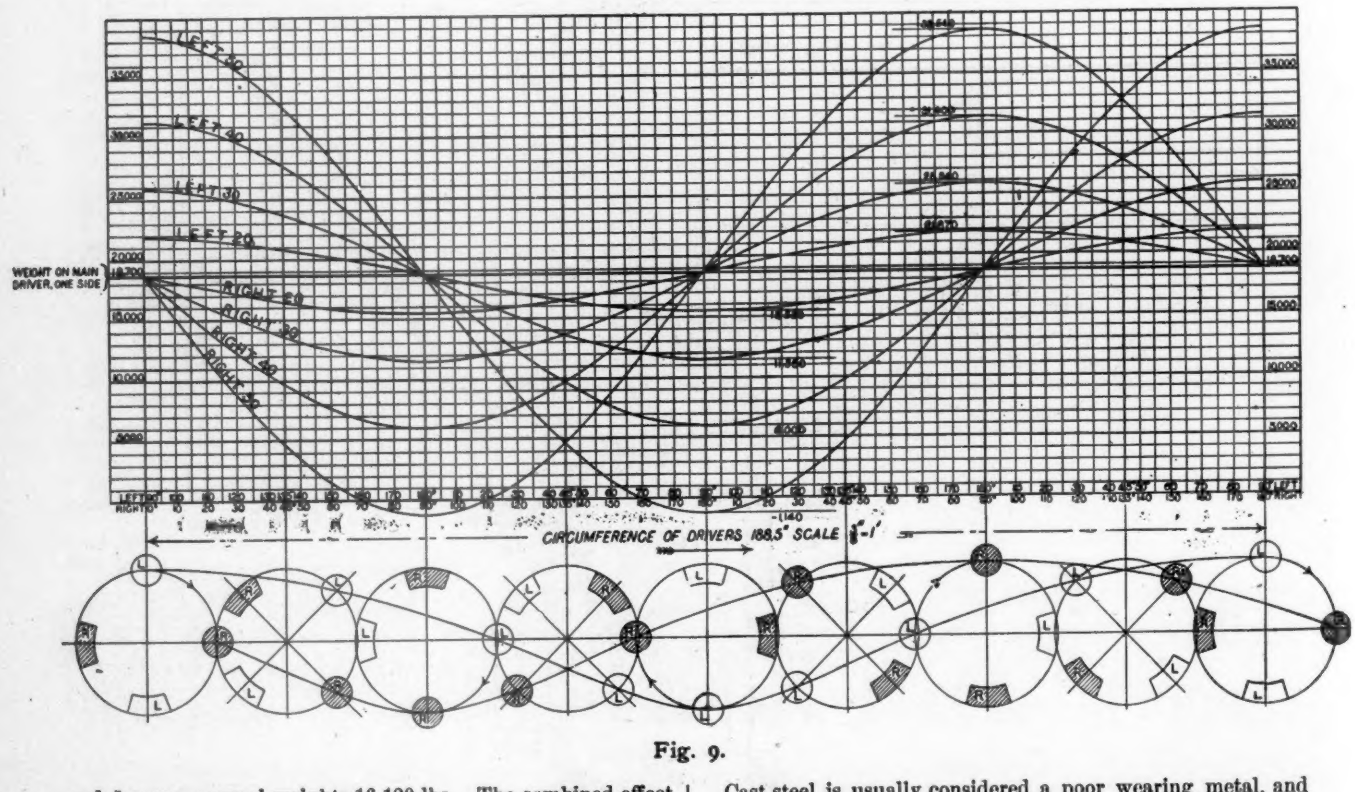


Fig. 9.

and decrease normal weights 16,120 lbs. The combined effect of these curves to increase or decrease the total weight is 22,796 lbs., making the alternations during half a revolution 45,592 lbs., and the actual weight on the drivers 49,504 minimum and 95,096 maximum.

These light parts have never been used collectively in service, but were designed by the writer as a practicable method of reducing the excessive weight without venturing into any doubtful or unusual construction.

Fig. 4 shows the front end of the main rod with a solid bushing. The rod is steel, milled out to an I section. This form of

Cast steel is usually considered a poor wearing metal, and its surfaces, when in sliding contact with other metals, are always protected by Babbitt tin, brass, or other metals having good wearing qualities. The piston-rod is of the usual construction, merely reduced in diameter, so as to allow ¼ in. or ⅜ in. wear and reduction in size before it is necessary to replace it.

It is not considered practicable to allow its diameter to be less than 2½ in. (when worn out) for the size of cylinder and steam pressure. The cross-head is of cast steel, shown in fig. 6, with tinned wearing surfaces.

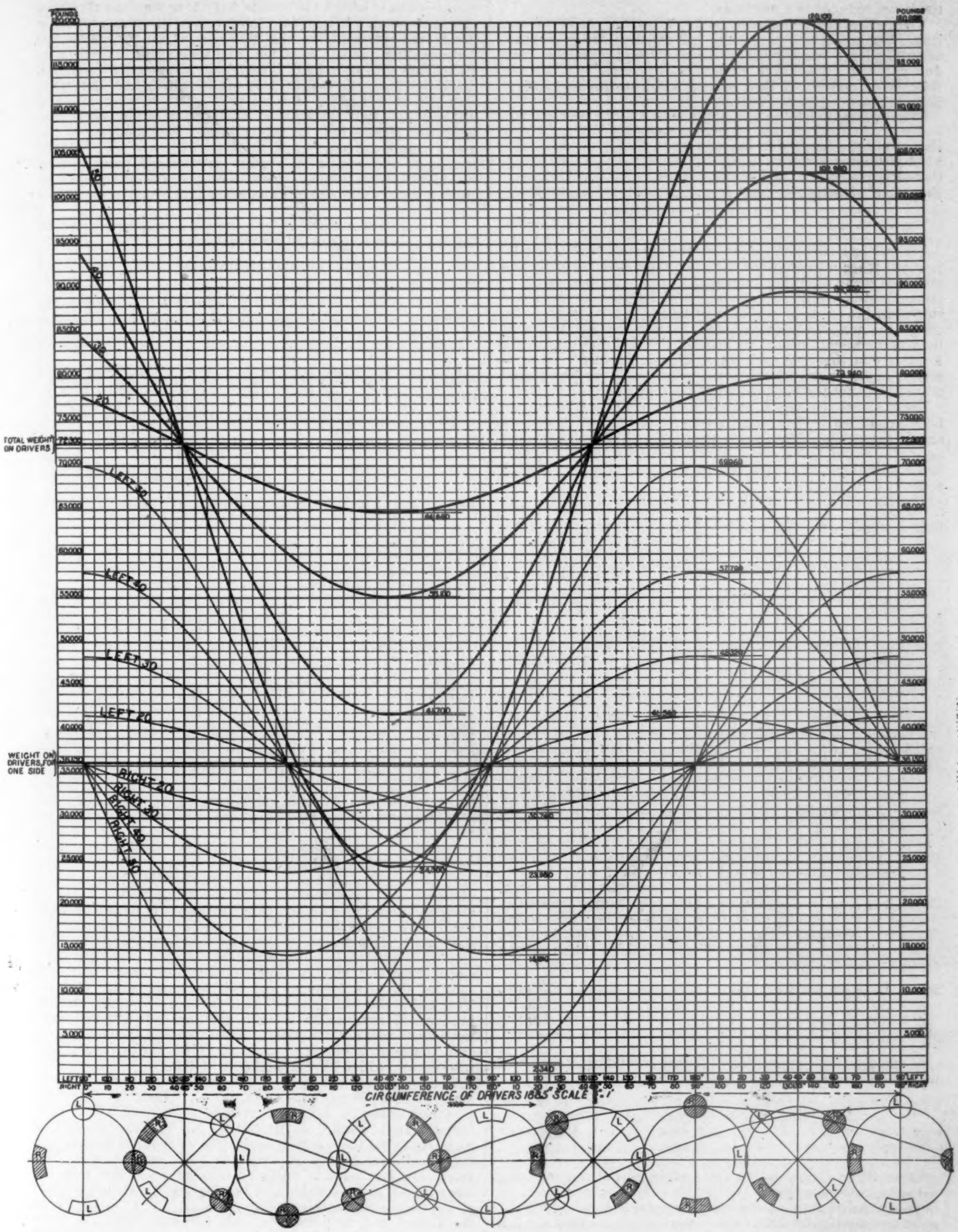

TOTAL WEIGHT ON DRIVERS
WEIGHT ON DRIVERS FOR ONE SIDE
LEFT 20
LEFT 30
LEFT 40
LEFT 50
RIGHT 20
RIGHT 30
RIGHT 40
RIGHT 50
CIRCUMFERENCE OF DRIVERS 185" SCALE

Fig. 10.

As nearly all engines, with the exception of those engaged wholly in switching service, run forward almost entirely, the upper wearing surfaces have been made unusually large, and the lower reduced to a minimum.

The guides are represented by fig. 7, and are made of cast iron. The upper one covers the full width of the cross-head, affording large bearing surfaces and efficient protection from dust and dirt. The lower guides are supported by a bolt and thimble, on account of their narrow width, to prevent springing when the engine is run backward.

The estimated weights are as follows :

Cast-steel cross-head with key and wrist-pin......	92.73 lbs.
Steel piston-rod and nut....................	90.36 "
Cast-steel piston-head and packing rings	129.20 "
Front half of main rod.........................	97.50 "
Total..	419.79 lbs.

The vertical effect of the counterbalances is very much intensified when a locomotive is hauled light with the main and side rods removed, being increased in the exact proportion of the amount of counterweight added to balance the main and side-rods, the effect of which must be added to increase or decrease the weights already found, for the vertical action of the counterweight placed to balance the reciprocating parts. Evidently in this case each wheel should be considered separately, as the main drivers have an excess of weight placed there to balance the back end of the main rod.

Fig. 8 shows the curves plotted for the same class of engines before considered. The back drivers for right and left side are shown separately. The speeds are 20, 30, 40, and 50 miles per hour, the latter being an excessive speed for freight trains, liable sometimes to be reached in exceptional cases, though scarcely ever exceeded.

The normal weight on this pair of wheels is 17,450 lbs.

Speed, 20 miles per hour;	min., 15,220 lbs.;	max.,	19,680 lbs.
" 30 " " "	" 12,420 "	"	22,480 "
" 40 " " "	" 8,510 "	"	26,390 "
" 50 " " "	" 3,480 "	"	31,420 "

Fig. 9 shows the curves plotted for main drivers at the same speeds. Normal weight on drivers, 18,700 lbs.

Speed, 20 miles per hour;	min., 15,530 lbs.;	max.,	21,870 lbs.
" 30 " " "	" 11,560 "	"	25,840 "
" 40 " " "	" 6,000 "	"	31,400 "
" 50 " " "	" – 1,140 "	"	38,540 "

At 50 miles per hour the driver lifts from the track, the weight being a minus quantity of 1,140 lbs., the curve being extended below the base-line, and the maximum weight 38,540 lbs.

Fig. 10 shows the curves of single, main, and back wheels combined for each side, as shown in the light full lines, and for the total combined effect of all four drivers, shown in the full heavy lines.

This diagram shows the lines for one side, and both sides in their true relation to the same base-line, and not from one horizontal line with two base-lines, as in figs. 1 and 3.

The diagram under consideration, made in this manner, shows it in a much more graphic and clear manner than when the eye is confused by more than one base-line ; the vertical distance showing at a glance the exact amount on the track at any point of the revolution. The normal weight on drivers for one side is 36,150 lbs.

Speed, 20 miles per hour;	min., 30,740 lbs.;	max.,	41,560 lbs.
" 30 " " "	" 23,980 "	"	48,320 "
" 40 " " "	" 14,510 "	"	57,790 "
" 50 " " "	" 2,340 "	"	69,960 "

In the combined curves for all four drivers, the total normal weight on drivers = 72,300 lbs.

Speed, 20 miles per hour;	min., 64,660 lbs.;	max.,	79,940 lbs.
" 30 " " "	" 55,100 "	"	89,500 "
" 40 " " "	" 41,700 "	"	102,900 "
" 50 " " "	" 24,500 "	"	120,100 "

In all these diagrams the full weight of the reciprocating parts has been balanced. While this cannot be claimed to be the universally accepted method of counterbalancing, it is by no means unusual or little used. Something less than the full weight of reciprocating parts can be used without injuring materially the smooth running of the engine. As the friction of the piston on the bottom of the cylinder and the packing surrounding the piston-rod have, no doubt, some slight influence in reducing the amount of weight required to accurately balance the horizontal motion of these parts, the practice at the present time would indicate that a very slight amount, ranging from 10 to not over 20 per cent. of the total weight, can be omitted without injurious jerking or fore-and-aft irregular movement. It therefore follows that the most promising line of improvement lies in a reduction of the weights of the reciprocating parts. It is not an extravagant statement to make, that by a little careful designing a very great reduction can be made in the weight, without impairing the efficiency, strength or durability of these parts. Much more attention has been paid in Europe to the reduction of weights of cross-heads and pistons than in this country. The tendency to the use of compound engines in the last few years has called attention to this matter in a more pronounced manner than would otherwise have occurred, owing to the enormously increased weight and size of cross-heads and pistons used in this class of engines.

The weight of reciprocating parts on a number of modern single-expansion engines is given below :

SIZE OF CYLINDERS.

	20 x 24.	21 x 26.	18 x 24.	19 x 24.	19 x 24.	18 x 24.	19 x 24.	19 x 24.	20 x 24.	19 x 24.	20 x 24.
½ main-rod....	217½	263	211	153½	152	170	166½	179½	206¾	200	234¼
Crosshead.....	240	261	138	190	201½	204	182	138	208	160	205
Piston and rod.	386	425	285	278	291	293	300	320	362	306	362
Total....	843½	949	634	621½	644½	667	648½	637½	776¾	666	801¼

(TO BE CONTINUED.)

BOILERS AND FEED-PUMPS OF THE UNITED STATES BATTLESHIP "TEXAS."

IN continuation of our description of the machinery of the United States battleship *Texas*, we present in this number engravings illustrating the details of the construction of the boilers and feed-pumps. Both were built at the Richmond Locomotive Works, of Richmond, Va., the boilers from the specifications furnished by the department, and the latter from the designs of Mr. C. J. Mellen, chief draftsman for the contractors. The boiler is of what may be called the standard type for the double-ended boilers of all of the vessels of the United States Navy, and differs only in detail from those of the *Minneapolis* and other vessels heretofore illustrated in the pages of THE AMERICAN ENGINEER.

There are four boilers, each having a mean diameter of 14 ft. and a length of 18 ft., and with six corrugated furnaces with a minimum diameter of 3 ft. 3 in. and a length of 6 ft. $8\frac{7}{8}$ in. There are 168 stay-tubes and 642 ordinary tubes in each boiler, the length between tube sheets being 6 ft. 9 in. The external diameter of all the tubes is $2\frac{1}{2}$ in.; the ordinary tubes are No. 9 B. W. G. in thickness, and are swelled to an outside diameter of $2\frac{9}{16}$ in. at the front ends, the back ends being expanded into the tube sheet and beaded over. The stay-tubes are reinforced at each end and swelled at the front end to a diameter of $2\frac{3}{4}$ in. Of these tubes 144 are $\frac{5}{16}$ in. thick, and 24 are $\frac{3}{8}$ in. thick ; all of them being threaded at both ends to fit the threads in the tube sheets, into which they are screwed and then made tight by expanding and beading over. All tube spacing is fixed at the uniform distance of $3\frac{1}{2}$ in., both vertically and horizontally, and so disposed that there are 136 tubes for each of the side furnaces and 133 for each center furnace. This makes the efficiency of each furnace the same, and the products of combustion of each are kept separate and apart until they reach the uptake. For this each furnace has its own combustion chamber made of $\frac{11}{32}$ in. plates, except the tube sheets, which have a thickness of $\frac{5}{8}$ in.

The furnaces are of the well-known Fox corrugated pattern, made of one piece of steel $\frac{1}{2}$ in. thick. These furnaces, like all others in use on American vessels, were made by the Continental Iron Works, of Brooklyn, N. Y. The method of manufacturing these corrugated furnaces requires special skill and special machinery in order to do it successfully. The sheets are first bent in ordinary bending rolls, and then the longitudinal seam is welded by heating the overlapping edges of the plate with furnaces using water gas as fuel, after which the heated part is passed between bending rolls. But little hand work is done, as hydraulic rams and lifts are used for forming the weld and handling the sheet. After the welding is completed the shell is heated in a circular and vertical gas furnace burning producer gas, into which the shell is lowered by a hydraulic crane. Here the temperature is raised

to a bright cherry red, and then the shell is carried to the corrugating rolls, where in about five minutes the work of corrugating is completed. These rolls have the general appearance of vertical bending rolls, except that the rolls are corrugated instead of being smooth. Owing to the rule regarding the size of the corrugations in the furnaces of marine boilers, one set of rolls is sufficient to do the work on all sizes of furnaces and all thicknesses of sheets. The rule, as adopted by the Board of United States Supervising Inspectors of Steam Vessels, is that the corrugations shall have a pitch of 6 in. and be $1\frac{1}{2}$ in. deep, and the formula used for the calculation of the thickness and steam pressure is

$$\frac{14{,}000}{D} \times T = \text{working pressure in pounds per square inch,}$$

in which

$$14{,}000 = \text{a constant;}$$
$$T = \text{thickness in inches;}$$
$$D = \text{mean diameter in inches.}$$

This naturally simplifies matters very much indeed, as there is no variation in the shape, but merely an increase in the thickness of the metal as the diameter or working pressure is increased.

CORRUGATED FLUES FOR BATTLESHIP "TEXAS," MADE BY THE CONTINENTAL IRON WORKS, BROOKLYN, N. Y.

In order to get one of the rolls through the shell, it is lifted out of the machine by a hydraulic lift and dropped back into place when the shell is in position. The machine is then started, being driven by its own engine. The corrugated roll, that was taken out in order to get the shell in place, turns in immovable bearings, while the other is crowded against it to produce the corrugations. It requires about five minutes to do this work. After the corrugations are completed any flanging that may be required for fastening to the boiler shell is done, after which it is annealed and tested for leakages. Flange steel having a tensile strength of not more than 65,000 lbs. per square inch of section is used for all corrugated furnaces.

There are 24 of these furnaces in the boilers of the *Texas*, a photo-engraving of them being shown on page 205.

The heating surface in each of these furnaces is 44.81 sq. ft., making 268.9 sq. ft. for the six furnaces in a boiler. The heating surface of the whole boiler may be divided as follows:

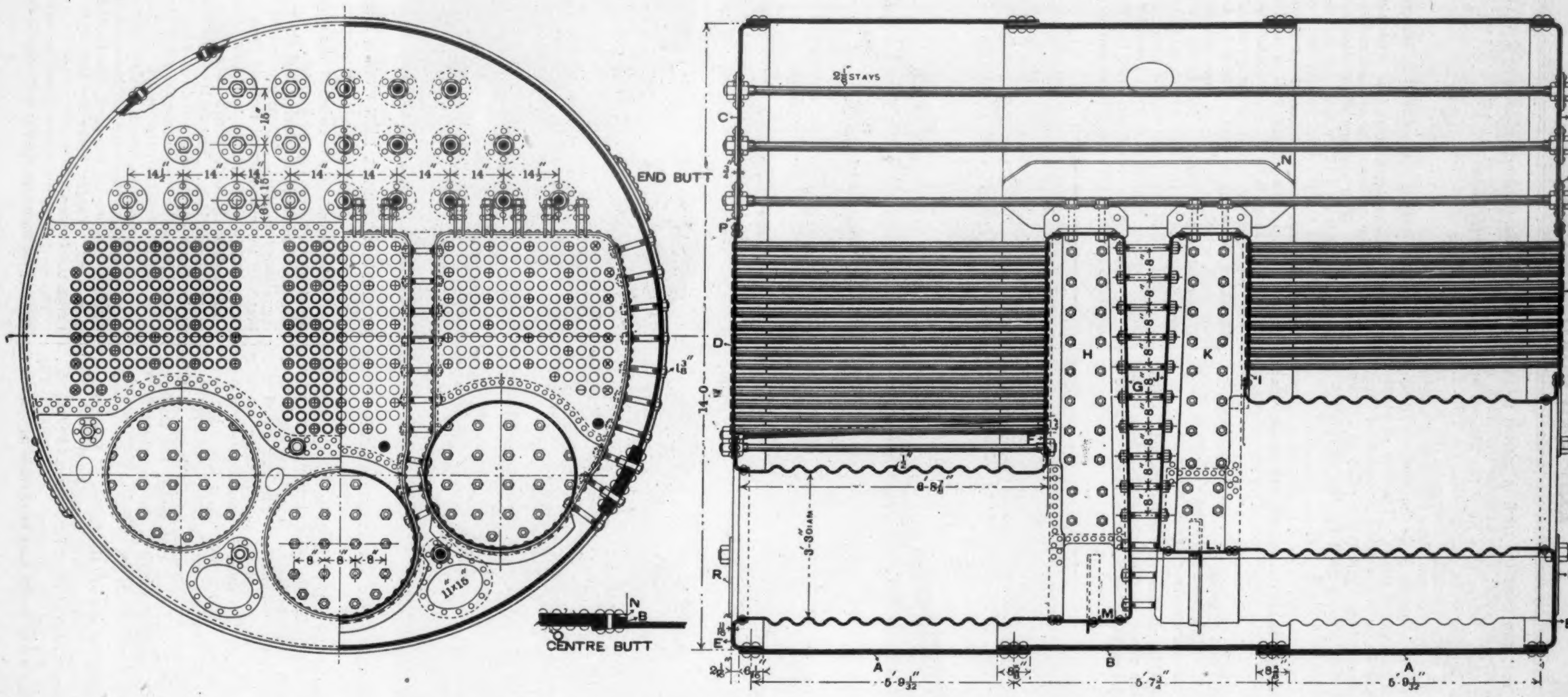
810 tubes $2\frac{1}{4}$ in. external diameter by 6 ft. 11 in. long	3,587 sq. ft.
6 corrugated furnaces	268.9 " "
6 combustion chambers	372.2 " "
Total	4,228.1 sq. ft.
Total heating surface for four boilers	16,912.4 " "

The grate bars are of cast iron with side bars of cast steel made to fit the corrugations of the furnaces, and with wrought-iron bearers. The average dimensions of the grate bars are 3 ft. 5 in. × 6 ft. 6 in., which, for the six furnaces, gives an area of 132.9 sq. ft., and for the four boilers 531.6 sq. ft. Comparing this area with that of the heating surface, we find that the ratio between the two is as 1 to 31.8. The area through the tubes is to the grate surface as 1 to 5.9.

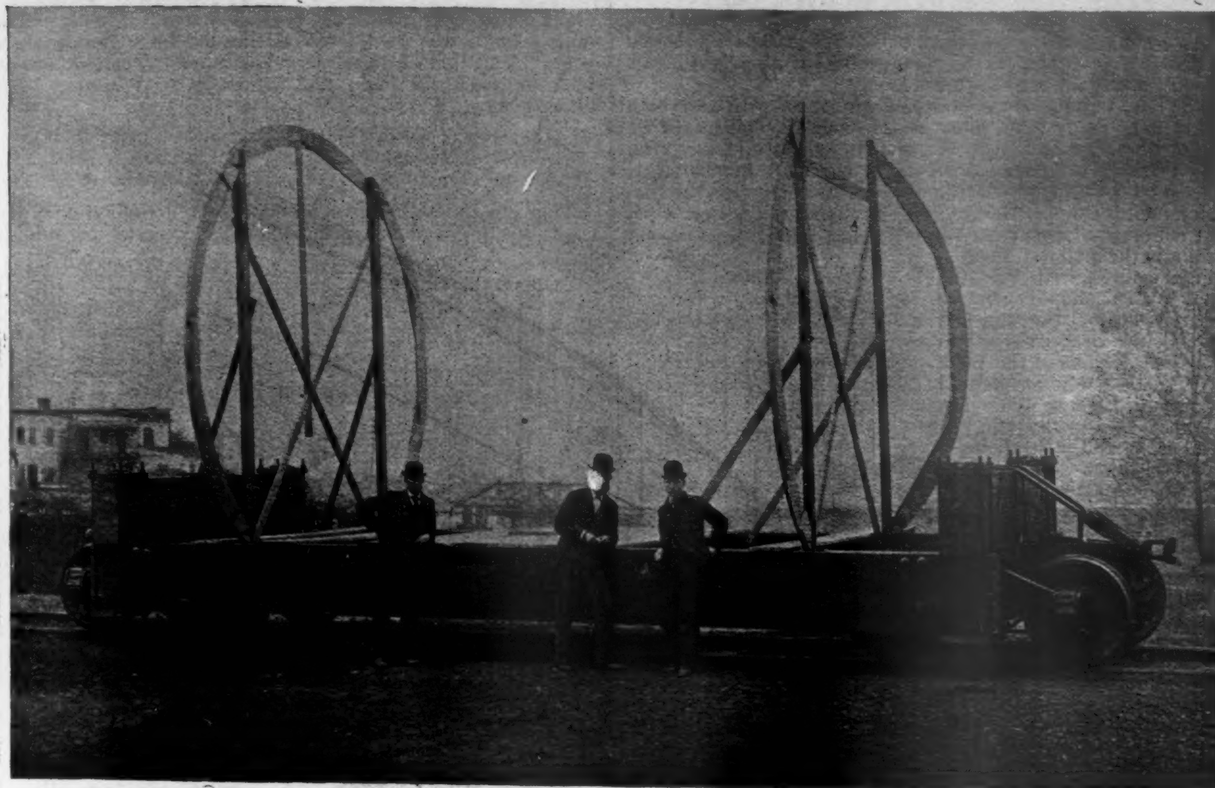
All plates, rivets, braces and stays are of open-hearth steel, the tubes also being of steel. Plates $1\frac{5}{32}$ in. thick are used for the shell, which is built up of three courses, each course being composed of two plates. The heads are of three plates riveted, as shown in the half-end elevation of the engraving on page 204. The upper and middle plates are $\frac{3}{4}$ in. thick, while the lower one, which is flanged inwardly at the furnaces, is $\frac{11}{16}$ in. thick. The tube sheets are $\frac{3}{4}$ in. thick, great care having been taken to get each pair accurately parallel. All of the tube holes are slightly rounded at the edges, and the holes for the stay-tubes were tapped in place.

A reference to the engraving will show the method of staying above the tubes. There are twenty-one $2\frac{1}{8}$ in. through braces in three horizontal rows in each boiler. Each row is spaced 14 in. from center to center horizontally, except the outer ones in the bottom row, which are $14\frac{1}{2}$ in., the vertical spacing being 15 in. The ends of the braces are expanded to $2\frac{1}{2}$ in. diameter, and are provided with nuts both inside and outside the boiler, the outer ones screwing up against washers $\frac{3}{4}$ in. thick riveted to the heads. The tube sheets are also stayed by three $1\frac{7}{8}$ in. braces in each that are swelled to $2\frac{1}{4}$ in., and screwed into them and further secured by one in the back tube sheet and two at the front, like the through braces already mentioned. Finally, there are two $2\frac{1}{8}$ in. through braces between the furnaces.

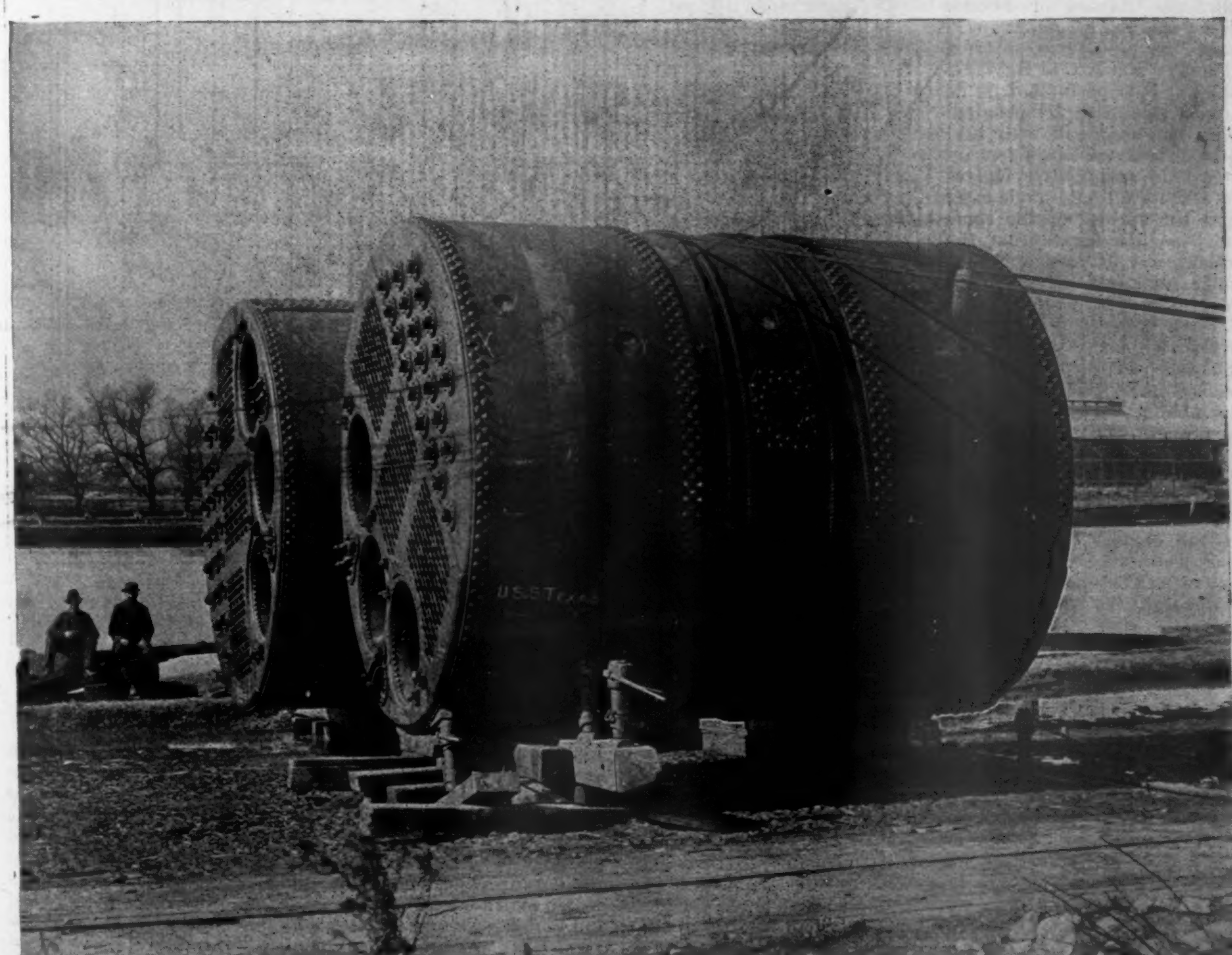
The staying of the combustion chambers is effected by stay-bolts $1\frac{3}{8}$ in. diameter spaced 8 in. apart, both horizontally and



BOILERS OF THE UNITED STATES BATTLESHIP "TEXAS," BUILT BY THE RICHMOND LOCOMOTIVE WORKS, RICHMOND, VA.



SPECIAL CAR FOR TRANSPORTING BOILERS OF THE UNITED STATES BATTLESHIP "TEXAS."



BOILERS OF THE UNITED STATES BATTLESHIP "TEXAS."

vertically. The tops are further stayed by bridge braces made of two steel plates $\frac{9}{16}$ in. thick, spaced 8 in. apart between centers. The bottom of the combustion chamber is stiffened by angles, and all braces are weldless.

The longitudinal seams of the shell are butted with welts both inside and outside $\frac{15}{16}$ in. thick treble riveted. This leaves the plate with 82 per cent. of its original strength, while the rivets, which are $1\frac{1}{4}$ in. diameter, driven in holes $1\frac{5}{16}$ in. diameter, possess 86 per cent. of the same strength. The circumferential joints are lapped and double riveted, the furnace joints and combustion chambers single riveted. In order to avoid strains in the material, the specifications required that the shell plates should not be sheared nearer the finished edge than a distance equal to half the thickness of the plate along the circumferential seam, nor nearer than the thickness along the longitudinal seam, and all rivet holes in the shell were drilled in place after bending.

Each boiler has two 11-in. × 15-in. manholes in each head, and a 12-in. × 16 in. manhole in the shell near the top of the middle section, in addition to which there are four 6-in. × 4-in. hand-holes in each head.

The boilers are divided into four groups, each in a separate water-tight compartment, with athwart ship fire-rooms entered through suitable air-locks.

All of the external fittings of the boilers are of composition metal, and are flanged and through riveted or bolted. Each boiler has an internal brass dry-pipe $8\frac{1}{2}$ in. internal diameter and No. 14 B. W. G. thick. It is perforated on its upper side with longitudinal slits 3 in. long, $\frac{1}{8}$ in. wide, and $\frac{1}{4}$ in. between slits. There are two $4\frac{1}{2}$ in. spring safety-valves on each shell but in one case, and the springs of the same have such a length that the valves can lift one-eighth of their diameter at 150 lbs. pressure.

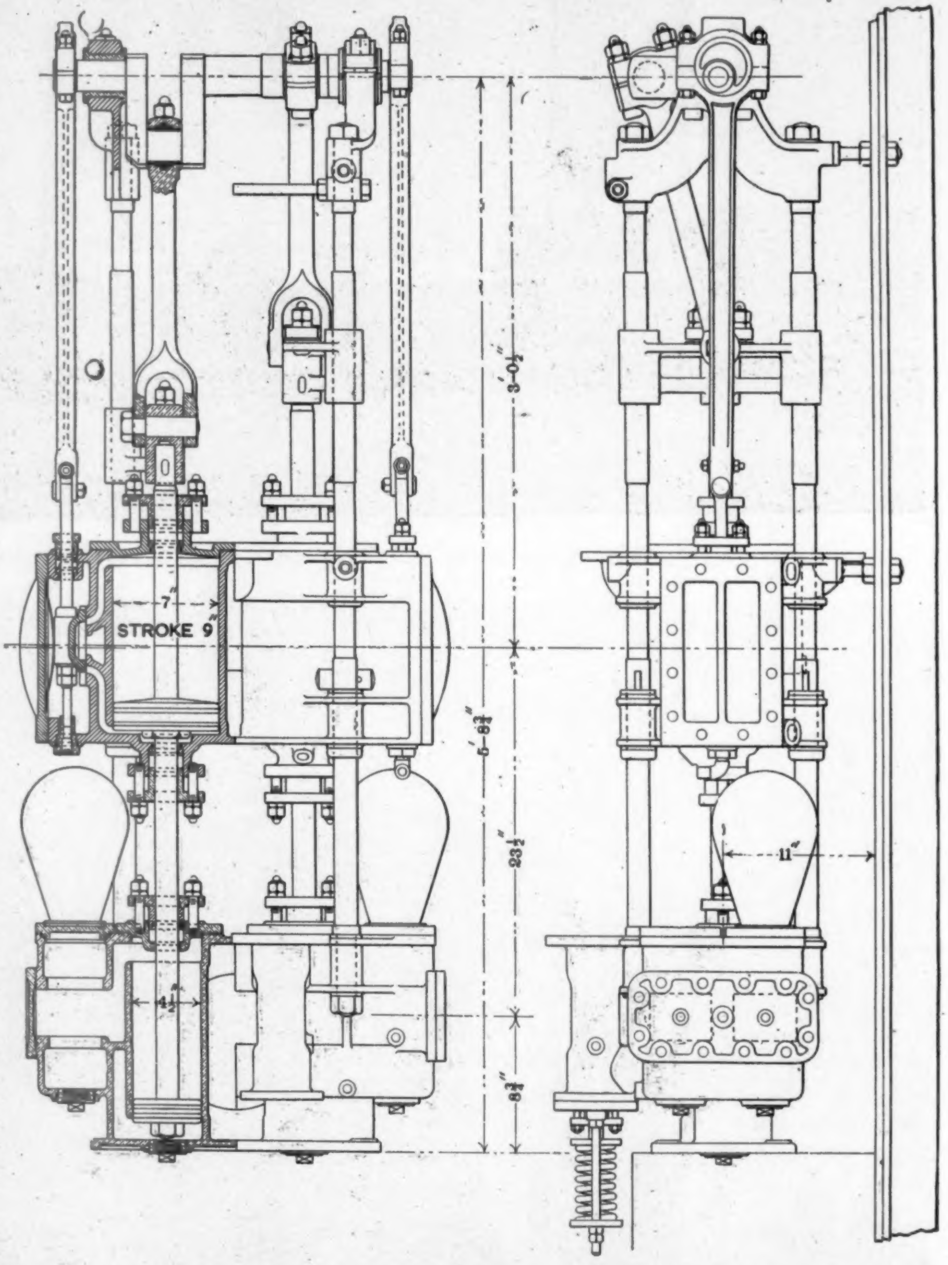
Each boiler is further provided with zinc protectors. There are 66 rolled zinc plates, each 8 in. × 16 in. × $\frac{1}{2}$ in. in each boiler. They are bolted to wrought-iron straps clamped to the stays. Each strap is filed bright where it comes in contact with the zinc and stay, the latter being also filed bright at the contact point. After they were bolted in place the outside of the joints were made water-tight by paint or cement.

After the boilers were finished at the Richmond Locomotive Works, it was necessary to construct a special car in order to transport them to a wharf on the James River, whence they were to be shipped to the Norfolk Navy Yard. This car is shown in the engraving that is reproduced from a photograph, and is on page 207. As there is a tunnel between the works and the wharf they were obliged to make the car very low. To accomplish this they took two ordinary diamond trucks and fitted a frame composed of heavy timbers around the outside, keeping them down as low as possible. Heavy pieces at the truck bolsters carried the center plates, and the boilers were carried at the center.

Closely allied with the boilers are the feed-pumps, and those illustrated were designed by Mr. Mellen for this particular place. Room is very precious on the *Texas*, and the pumps are made to occupy the least possible amount of space. The same pattern was used for feed, fire and bilge-pumps, there being 12 all told of the design illustrated. There is one in each fire-room for main and auxiliary feed-pumps. The dimensions are :

Diameter of steam cylinders	7 in.
" " water "	$4\frac{1}{2}$ "
Stroke	9 "

They are duplex pumps with cranks set at right angles, and they are capable of delivering 100 galls. of water per minute



FIRE, BILGE AND FEED PUMPS, UNITED STATES BATTLESHIP "TEXAS."

against the boiler pressure. At first it was intended to fit them with fly-wheels, in order to steady the motion, but this was found to be unnecessary. The pumps are so designed that the packing of the water pistons can be reached from the tops of the cylinders. The main feed-pumps, which are in the after fire-room, are fed from the feed tanks only, but the auxiliary pumps, located in the forward fire-room, are connected to draw from the sea, feed tank, bilge or boilers at will, and to deliver either into the auxiliary feed-pipe, fire main or overboard. As fire-pumps they can be worked under a steam pressure of 60 lbs. per square inch. Each pump has a breadth over all of 2 ft. 4 in., and stands 1 ft. 10 in. out from the partition against which it is bolted.

SIGNAL APPARATUS IN USE ON THE GRAND CENTRAL RAILWAY OF BELGIUM.*

By Leopold Kirsch.

(Continued from page 163.)

Special Detail Effecting the Contact of the Points.—We have said that the central eccentrics ought to effect a contact—that is to say, they ought to bring up against the main-rail without causing the destruction or the serious wearing of any important part whatsoever of the operating mechanism of the switch apparatus. Furthermore, the homing of an eccentric ought never to be beyond the control of the switchman. Finally, the final wearing, which is caused by this striking of a point, should be easily and quickly taken up. We have

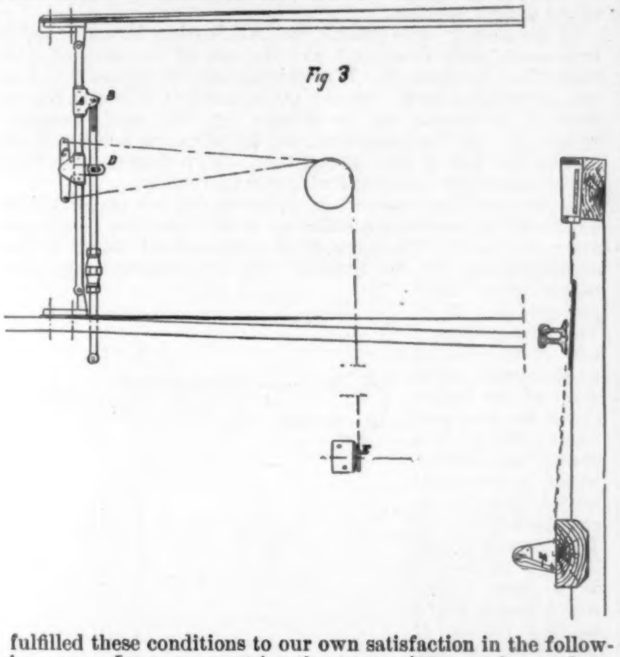


Fig 3

fulfilled these conditions to our own satisfaction in the following way: In our eccentrics the two points are fastened together by three connecting tie-bars. We have fastened the first of these tie bars to the operating rod by means of a fixed fork, *A*, and a pin, *B* (fig. 3). This pin *B* is strong enough to guarantee the solidity of the two tie bars, which are fastened together under ordinary circumstances; but it is not as strong as the other parts of the operating mechanism, so that in case of cramping it is destroyed by shearing without resulting in any serious injury to the other parts. It is enough to have a number of these pins on hand in order that the breakages which are thus caused may be quickly repaired.

In case of running through the points the operating rod remains motionless while the connecting bars are displaced with the points. We have profited by this fact to notify the signalman of every case which occurs, even though it may be in his immediate neighborhood. In order to do this, the connecting bar carries a piece, *C*, in the form of a T, which turns about the crossing point of its two branches. Two of these are placed parallel to the connecting bar, and end in an eye which is fastened to the end of a steel wire. The third arm is placed at right angles to the tie bars, and has an oblong opening at its end, into which a button fastened on the operating rod can move. The two ends of the wire or chord, above referred to, unite into one, which passes over a pulley and is fastened to the end of the shears *E*, between the blades of which the transmitting wire of the mechanism passes. When everything is working normally the tie rods and the operating bar move together in parallel directions, consequently the part *C* moves, but does not turn about its center, and the end of the shears remains immovable. But if it strikes, the tie bar slides over the operating bar, the piece *C* turns and pulls upon the chord, so that the shears closes its jaws and cuts off the transmitting wire. Finally, in the cabin the locking bar falls and fastens the levers which control the switch points that have just been injured. In order to bring the apparatus back into good working condition, a piece of steel wire of a given length, supplies of which are kept in the signal cabins, is put back to take the place of that portion which was cut off in the shears.

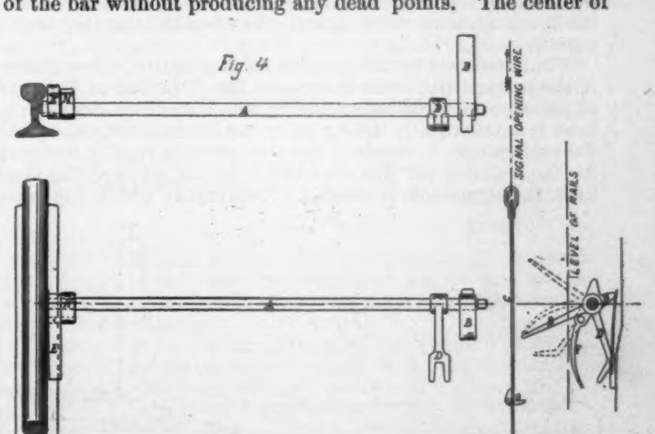
Special Arrangements for Temporarily Locking the Points.—It is sometimes necessary to have such a relationship between the signal and an eccentric, that the position of the point cannot be changed after a signal has been set to clear until the train has passed the said point. It is especially desirable that this should be done at small stations on single-track roads. The arrangement used should be such that only the single opening wire for the signal can be used; it ought to be independent of the closing wire of the signal; finally, it ought to be brought back into the normal position by the train or by hand.

To satisfy all these conditions of the problem, we add an operating mechanism to the eccentric consisting of the following parts. On the horizontal rotating shaft *A* (fig. 4), located at right angles to the track and close to the part which moves the eccentric, we key a crank, *B*, and a fork, *D*, to one end, while at the other end we have a cam, *H*, which can move in one direction only, and the pedal *E* that turns freely about the shaft *A*. The opening wire of the signal passes along the plan of rotation of the crank *B*, above which it is replaced by an iron bar, *C*, carrying a small tappet, *c*, which can only turn in one direction. When the opening wire is drawn in the direction of the arrow, the tappet *c* engages the crank *B* and carries it over into the position indicated by the dotted lines; when the wire is hauled in the opposite direction, the tappet *c* lies along the bar which passes above the crank *B* without carrying it with it in its movement.

The shaft *A* is turned by the movement of the crank *B* and raises the fork *D*, which thus locks the operating portions of the point, and the pedal *E* rises until it occupies the position indicated by the dotted line. When the train reaches the point it pushes the pedal *E*, the fork *D*, and the crank *B* back into their original position, and the point is again free. If, for any reason, a signal, which has been set to clear, should be brought back to the danger position before the train passes there is nothing to hinder it; but, in spite of the closing of the signal, the point will be left locked in the position which it occupied at the time the signal was opened. In order to free it a man must go to the point, and with his foot or hand push down the pedal *E*. On the other hand, if the signal has not been set to clear, it will be necessary to raise the pedal *E* by hand, and then the latter will fall of itself into its proper position, and the point will be free.

Safety Device for Preventing a Premature Movement of the Point.—When an eccentric is some distance from the operating station or some obstruction intercepts the line of sight, it is frequently quite difficult for the signalman to determine with certainty whether the entire train has cleared the point or not. In cases of this kind, in order to prevent a premature movement, we set a detector bar, *A* (fig. 5), ahead of the point, and move it by the same method of transmission as the point itself is moved. This bar is carried by a number of larger or smaller bell cranks *B*, turning about their angle *G*; all these bell cranks are coupled together by a bar, *H*; the bar can be moved from top down or from bottom up, but by the means adopted the movement is communicated uniformly to all parts of the bar without producing any dead points. The center of

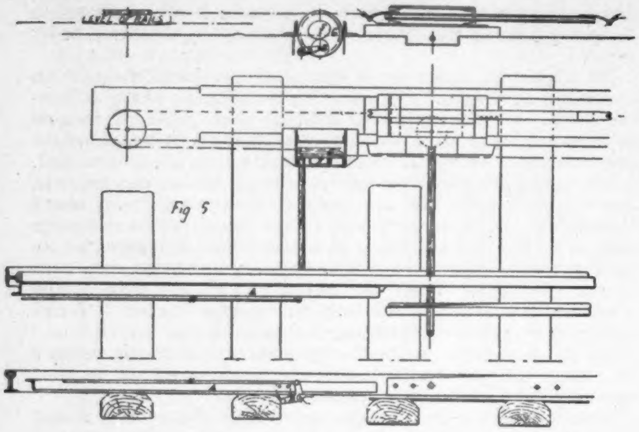
Fig. 4



rotation *A*, of one of the end bell cranks *B*, is extended out toward operating mechanism of the points, and ends in this direction in the crank *D* provided with the cam *E*. The weight of the bar *A* tends to push the cam *E* up, and this consequently presses against the eccentric *F* that can describe a complete revolution, and which is rigidly fastened to the pul-

* Bulletin of the International Commission of the Railway Congress.

ley G, having two grooves over which the transmission wire passes. While the transmission wire is doing its regular work, the pulley G and the cam F turn on themselves, and the cam E is lowered and then rises while the bar A is rapidly lifted. It remains motionless for a certain length of time, and then comes back to its initial position. The perimeter of the cam F is so outlined that the three periods of movement of the bar A correspond respectively to the three periods of movement of the operating mechanism of the point. If a car wheel is above

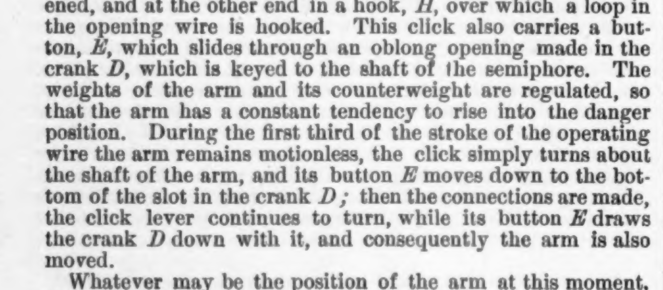


any part of the bar A it cannot rise; the cam E, and consequently the cam F, the pulley G and the transmitting wire are locked before the point begins to move.

By grouping these different details it is possible with a single lever to operate the point, and at the same time do away with every false motion and prevent a premature movement of the point.

Mechanism for Operating the Semiphore Signals.—The ends of the two transmitting wires are fixed respectively to a point on the outside perimeter of the pulleys A and B (fig. 6), which turn freely on the same shaft, located at the foot of the mast. Each of these pulleys carries a small central drum about which a wire that runs up along the mast is bent in a direction opposite to that of the transmitting wire. One of these others is attached to the ends of the click lever C. This click C, which can turn and which rests freely on the shaft of the arm, ends at one end in an eyelet C, to which the closing wire is fastened, and at the other end in a hook, H, over which a loop in the opening wire is hooked. This click also carries a button, E, which slides through an oblong opening made in the crank D, which is keyed to the shaft of the semiphore. The weights of the arm and its counterweight are regulated, so that the arm has a constant tendency to rise into the danger position. During the first third of the stroke of the operating wire the arm remains motionless, the click simply turns about the shaft of the arm, and its button E moves down to the bottom of the slot in the crank D; then the connections are made, the click lever continues to turn, while its button E draws the crank D down with it, and consequently the arm is also moved.

Whatever may be the position of the arm at this moment, if the transmitting wire is broken, the click leaves the shaft of the arm and turns about the button E, and the arm remains in or is automatically drawn up to the danger position. Until the broken wire is repaired the arm remains rigidly fastened. As the locking bar has also fallen in the cabin at the same time, the signalman is notified of the injury which has taken

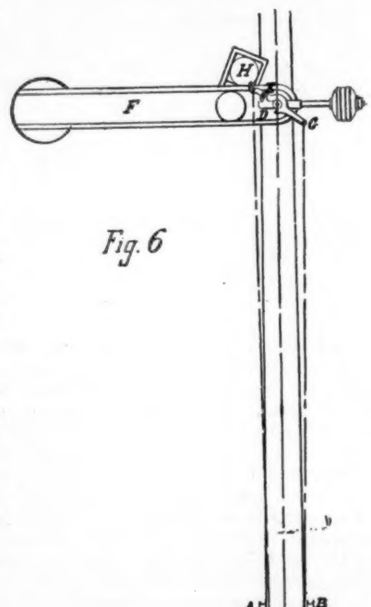


place, and it is rendered impossible for him to set the signals in such a way that there can be any danger whatever.

Mechanism for Operating Distance Signals.—Our distance signals are composed of a rectangular disk, fixed upon a vertical mast which can turn through an arc of 90°, and are always locked in either one or the other of their extreme positions by the operating mechanism. The latter is similar in every particular, even in its dimensions, to the operating mechanism of the points which we have just described; and it differs only in principle in certain details intended to bring the signal back to danger in case of the breakage of either of the transmitting wires. The rack bar ends in two floating levers A and B (fig. 7), which can turn about either of their extremities, and are fastened to each other by the rod G. The floating lever A is provided with an eye D, into which the end of the closing wire is fastened, and the floating lever B carries an open hook E over which the loop at the end of the opening wire is hooked. The distance of the eyes from the points of rotation of these floating levers is regulated, so that under normal conditions the two floating levers are inclined as shown in the engraving. If the opening wire breaks when the signal is at danger, the signal remains motionless; if, at the moment of rupture the signal is at clear, it is immediately drawn back to the danger position.

If the closing wire breaks, the two floating levers A and B turn about their inner end, and the eye of the opening wire slips off of the hook E. If at this instant the signal is at danger, it remains there; on the other hand, if it is standing at clear, it is drawn up to danger by the small counterweight F. At the same time the signalman is notified of the fact by the fall of the locking bar, which fastens all of the levers which are connected with this movement.

Expansion Compensator.—In order to put our transmissions outside of the pale of the influence of the variations of temperature, we have had recourse to an arrangement shown by the accompanying fig. 8. Each of the two transmitting wires passes over three pulleys A, B, C. The two pulleys A and B turn about fixed shafts. The shaft of the pulley C can be displaced vertically; it is placed in a stirrup, which is constantly pulled down by the counterweight E. This counterweight is hung on the end of a steel chord which passes over a hauling pulley, D, carried by the stirrup, and whose opposite end is fastened at F. Finally, the stirrup is provided on its lower side by the lateral spurs H; it carries the pulleys C and D of the two wires belonging to the same system of transmission, and it moves between two vertical guides which are provided with a series of teeth for the purpose of checking its motion.



When it is at rest the two wires have practically the same tension, and the stirrup which hangs almost vertically can move freely between its two guides; the wires can then lengthen or shorten at will. When a strain is put upon one of the wires the equilibrium is broken and the stirrup is swung to the right or the left, until its spur catches in one of the lateral teeth of its guides. The stirrup then becomes fixed, and its rigidity increases with the strain that is put upon the wire. By using a convenient spacing between the pulleys A and B and varying the weight of the counterpoise E more or less, according to the length of the transmission, it is possible to keep the wire under a constant tension, or at least to render the variations between the extreme tension so insignificant as to be practically of no account. This compensator, although very light, is very strong. It is inexpensive; its action is constant, and it is subject to no disarrangement. It can be placed in the narrowest passage allowed for the swinging of the wires either below the ground or above.

Owing to the apparatus which we have just described, and in view of the efficiency which has been demonstrated by ample experience, we believe that it may be said that the apparatus used by the Grand Central Railway of Belgium furnishes

an entirely satisfactory solution of the problem of operating signals and points at a distance by means of wire transmissions. The first applications were made for small stations on single-track lines. In many of these small stations the local traffic is insignificant. Nevertheless, the increase in traffic and the amount of switching of trains required the presence of a man at each end of the station to operate the entrance signal and the entering points. These men were unoccupied during the greater portion of the day. The use of the apparatus which we have just described permits the operation of the eccentrics for the switches and the signals for entering and leaving to be brought together in the office of the station

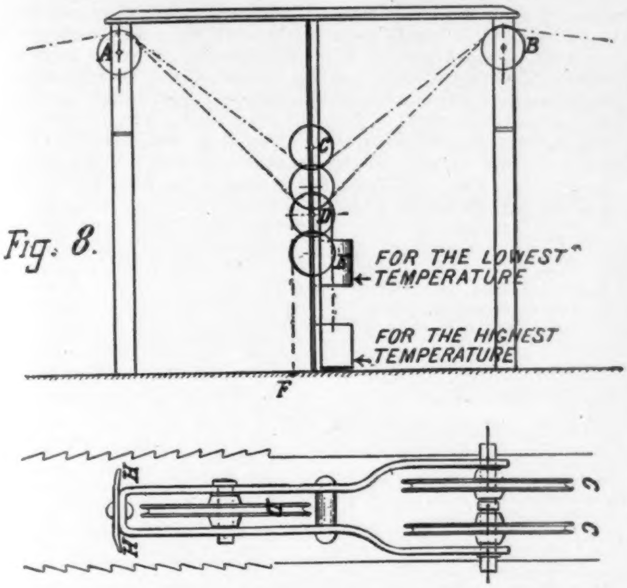


Fig. 8.

master or near it, and their operation be intrusted to the station agent. With a six-lever apparatus, costing on an average about $1000, it is possible to save the wages of one man, besides *considerably increasing the safety of the service.* The management of the Grand Central Railway of Belgium has also extended the applications of the apparatus in question, especially in the stations at Vlodrop and Maestricht. In the first case the signals and corresponding points were not only brought together, but the operation of different eccentrics were placed upon a belt-line track that was used in making up trains.

HYDRAULIC BOAT LIFTS.

By G. Braet.

It is well known that locks as ordinarily constructed have two very serious disadvantages—namely, the slight difference in level possible between the two sections of the canal and the large consumption of water. These disadvantages are especially felt where it is necessary to have a very considerable difference in level in a short length, and where water is frequently lacking for feeding the locks and thus raising or lowering boats from one level to the other. The engineers of bridges and highways in France have been compelled, in certain instances that were particularly difficult, to resort to other means, and have designed machinery for transferring boats from the upper level to the lower level and back again in some other manner than by that of locks—that is to say, in some other way than by allowing the boats to settle down by lowering the level of the water. Up to a very recent period it was only in America, Germany, England and France that systems of this kind have been adopted in any way. In America on the Morris Canal, and on the Continent of Europe in the Prussian Oberland on the right bank of the Vistula, boats have been raised on a car moving up an inclined plane. In Scotland, on the Mouckland Canal at Black Hill, boats have also been raised, in a cradle on wheels, up an inclined plane.

A later system, built after the plans of the well-known English engineers, L. & E. Clark and G. Standfield, and which in our opinion is fully as well designed and no less practical, has been built near Nortwich at Anderton in Cheshire, England. It consists of a cradle wherein the boat is lifted perpendicularly by a piston driven by water power.

The same system of Clark lifts, similar to those of Standfield, was adopted in 1882 in France, at Fontinettes, in the Department of the North, on the Naufosse Canal, effecting a communication between the port of the Pas de Calais with Lille and Belgium on one hand, and Paris and the basin of the Seine on the other.

In 1888, and we think this is the most recent application which has been made of this kind of installation, the Central Canal in Belgium, which connects the canal from Charleroy to Brussels with the canal running from Mons to Condé, has also been provided with hydraulic lifts for boats built after the Anderton type, but slightly modified in certain details.

Let us see, then, of what the lift or hydraulic elevator designed by Messrs. Clark and Standfield consists. This installation practically includes two cradles, kind of immense rectangular basins full of water, tight at the sides and closed at the ends by very tight gates, so that no water can escape. Each of these cradles or basins is carried at its center by a piston which moves in a large cylinder. The two presses are connected in such a manner that the two cradles hold each other in equilibrium. When a communication is opened between the two by means of a pipe provided with a cut-off valve, the two cradles can be alternately raised or lowered to the top or bottom level. In order to accomplish this the upper cradle is loaded, and the actual method of doing this is to put more water in so that it thus becomes the heavier, breaks the equilibrium, and descends to the lower level, driving the other cradle at the same time to the upper level. The elevators are thus operated like an immense Roberval balance, whose platforms are these metallic cradles.

At Anderton the dimensions of the cradles are as follows: Length, 75 ft.; breadth, 15 ft. 8½ in.; depth, 6 ft. 1½ in. When the cradles are at the lower end of their stroke they are immersed in the lower lock. At the upper end they abut against a metallic aqueduct against the face of which a round piece of rubber is fastened having a diameter of 3 in. The rising cradle comes up against this rubber, compressing it, and thus forming a tight joint. The pistons of the cradles are made of cast iron, and the hydraulic cylinders in which they move are of the same material. The weight of the contained water is about 240 tons. At the two ends of the cradles the iron gates slide in vertical grooves and rest against a rubber packing by which the tightness of the basin is obtained. In order to prevent the cradles from turning they are guided in their vertical movement at the four corners by cast-iron shoes sliding against columns of the same material.

The lift at Anderton was put into service in July, 1879, and worked regularly up to April 18, 1882, at which time it was accidentally disabled by the breakage of one of the cast-iron cylinders, an accident which was soon repaired. The fracture that occurred, as was shown by an examination of the cylinder after the accident, was due to the bad quality of the cast iron and to the fact that the foundations at the bottom of the cylinder were made of soft wood that had crushed in, thus developing strains in the metal. After the necessary repairs had been made it is reported that the lift at Anderton continued to give very good results in service.

Messrs. Clark & Standfield have furthermore perfected their system by doing away with the immersion of the descending cradle into the lower lock, by causing it to descend into a dry basin, and by balancing the two cradles in their every position by means of compensators. The expense of the construction of the Anderton lift was:

Metallic portions	$139,840
Foundations and masonry	90,060
Total	$229,900

The time for lifting a boat with the Anderton lift is about eight minutes, and it requires one hour and 30 minutes at Rounton, near Anderton, to pass over the same difference in level by means of locks.

At Fontinettes, in the Department of the North of France, where the difference in level is 43 ft. 8½ in., the descending cradle drops into a dry basin, and the two cradles are held in equilibrium by means of compensators. The dimensions of these cradles are as follows: Length, 132 ft. 10½ in.; breadth, 18 ft. 4½ in.; depth of water, 6 ft. 6¾ in.

The dry joint between the aqueduct and the end of the cradle is obtained by means of a kind of rubber bolster fastened to the face of the aqueduct, and which is inflated by means of compressed air, thus closing the joint between the cradle and the aqueduct. The gates at the end of the cradle are raised vertically by hydraulic presses which give them a very rapid movement. The danger of using cast iron for the

manufacture of the presses having been brought into notice by the Anderton accident, the Fontinettes presses are made of rolled steel. The cylinder is formed of rings rolled without any weld of a rectangular section, having a thickness of 2.2 in. and a height of 5.5 in. The rings are let into one another for half their thickness by a joint .2 in. in height. The ties connecting the upper and lower sections are made of hammered cast steel. The steel used for the manufacture of the sections has a tensile strength of 85,300 lbs. per square inch, and has an elongation at the point of rupture of 12 per cent. In order to make sure that the tightness of the press is as perfect as possible, an internal lining of copper has been put in that has a thickness of .1 in. and is made of a single piece. This system of elevator is very expensive, rising to a total of $210,000, which may be itemized as follows: $120,000 for the metallic portions and $90,000 for the foundations and masonry.

According to the reports the time of passage of boats at Fontinettes is not more than about 19 minutes by the lift, while previously it was one hour, 49 minutes when done by means of five locks. The saving in time thus realized is, therefore, a very important one.

In Belgium, on the Central Canal at Louviere, the difference in level overcome by means of hydraulic lifts is about 217 ft. 2 in. in a distance of 5 miles. Of these lifts, of which there are four, and which have a capacity of lifting boats of about 390 tons capacity, three have a possible height of fall of 55 ft. 6.5 in., and the fourth has a height of fall of 63 ft 7¾ in. The cradles have a length of 142 ft., a breadth of 19 ft., and a depth of water of 7 ft. 10½ in. They are guided in their vertical movement independently of the center guiding, by metallic columns bound together by means of handsome foot-bridges that give it great strength in all directions. The pistons, which are of cast iron, as in the other lifts, have a total height of 64 ft., a thickness of 3 in, and an external diameter of 6 ft. 6¾ in. The total weight of each of them, including the head, is 187,400 lbs. As for the cylinders, they differ from the lifts at Anderton and Fontinettes, in that they have an internal diameter of 6 ft. 9 in., and are composed of nine cast rings with a height of 6 ft. 10½ in. and a thickness of 4 in., with steel hoops having a thickness of 3¼ in.

These hoops are placed over the joints hot, and have a thickness of 2 in., a height of 6 in. The steel of which they are made has a tensile strength of 64,000 lbs. per square inch, showing an elongation of 20 per cent. at the point of rupture.

The cylinders rest on a timber foundation having a diameter of 13 ft., which rests on a foundation of broken stone and cement. The gates at the top and bottom of the cradles are raised vertically by means of chains driven by special turbines. The tightness of the joint between the cradle and the aqueduct and the metallic canal at the bottom is obtained by means of metallic joints with rubber packing, which press up against the ends of the cradles, and are moved parallel to each other in inclined planes by means of hydraulic presses. The packing at the bottom rises to form the tight joint, while that at the top drops. In case of accident, or when it is necessary to repair a cradle, the other can work independently. In order to do this two turbines of 69 H.P. each pump water into an accumulator under a pressure of 40 atmospheres, and this drives the piston of the lift.

The metallic portion of the lift at Louviere cost $163,400; the foundations and masonry cost $76,000. The total length of time required for the passage of a boat, both raising and lowering, averages eight minutes. The system which it replaces at Louviere had five ordinary locks, and consequently it is readily seen that a very great saving of time is obtained.

The preceding descriptions are, for the most part, taken from a paper on "Hydraulic Lifts for Boats," by Mr. Ch. Fréson, Engineer of the Société Cockerill, and published in the *Moniteur des interêts Matériel.*

THE RAM, IN ACTION AND IN ACCIDENT.

A PAPER was read, recently, by Mr. W. Laird Clowes, at the Royal United Service Institution in London, of which the *Times* gave the following report:

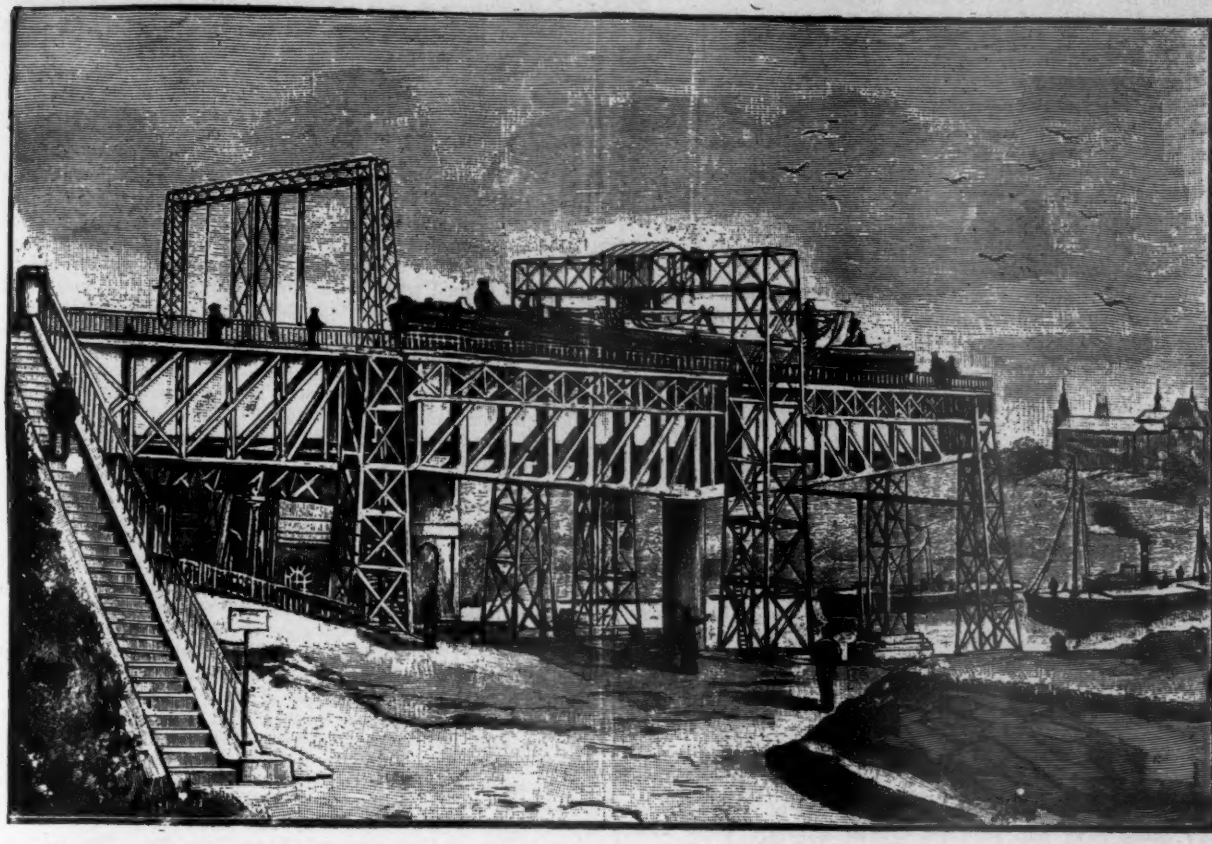
"I have heard naval officers, of all ranks from the lowest to the highest, and in this theater as well as elsewhere, express themselves in very sanguine tones concerning the future of the ram in naval warfare. I do not by any means intend to imply that all naval officers appear to believe to the same extent in the efficacy of this weapon. But I have known many, and among them officers of great experience at sea, who by their utterances suggest that, given slight superiority of speed and good handling, one ship can, without much difficulty, be made to ram another, even when the other is under full control and has plenty of sea room in which to manœuvre. This view of the capabilities of the ram has always, though in a loose and vague kind of way, been widely held; and I venture to think that the number of those who hold it has increased of late, and especially since last June, when the country had to lament the terrible and dramatic fate of the *Victoria*, and of so many of her gallant officers and men. But, recollecting as I do that naval officers and practical men have but little leisure for the study of the past, I am encouraged to lay before them a number of facts which I have assembled, and, with all deference, to indicate certain conclusions which those facts seem to force upon the mind of a very devoted, and I trust wholly unprejudiced, student of recent, as well as of ancient, naval history. I have made a detailed list of 74 cases of attempted ramming in what may be called modern naval warfare. I have included here all the cases, since the outbreak of the American War of Secession, on which I have been able to lay my hand. The list must not, therefore, be regarded as a list of selected examples. No doubt I have omitted some cases, but I have intentionally omitted none. The following summaries of the results to would-be rammer and intended rammed in the 74 examples are, I think, very suggestive. The results, so far as the ships intended to be rammed are concerned, were:

Previous situation of the ship attempted to be rammed.	Total number of cases	Effect upon the ship attempted to be rammed.				
		Nil.	Slightly damaged.	Seriously damaged.	Disabled.	Sunk.
Under steam with sea-room	32	26	5	1	..	..
Under steam in narrow waters	32	9	9	3	2	9
Unmanageable	4	1	..	1	..	2
At anchor	6	..	4	..	..	2
Total	74	36	18	5	2	13

The results, so far as the ships ramming are concerned, were:

	Effect upon the ship attempting to ram.				
	Nil.	Slightly damaged.	Seriously damaged.	Disabled (run ashore)	Sunk.
Total number of cases, 74	56	13	3	1	1

It will be observed that in 42 out of the whole number of 74 cited attempts at ramming, damage of some kind or other was done to one or both ships. In 24 of these 42 cases of effectual collision, the ramming ship received no damage worth mentioning; but in seven cases the ramming ship did herself about as much harm as she did to her opponent; and in seven other cases she injured herself even more severely than she injured her enemy. In no case did both rammer and rammed sink. All these cases occurred, of course, before the automobile torpedo had developed into anything like a perfect weapon, and most of them before the introduction of heavy breech-loading and light quick-firing guns. The obvious conclusions are somewhat remarkable. One is that, if two ships have sea room and be fully under control, it is actually more dangerous to try to employ than to try to escape the ram, and that, under these conditions, it is practically hopeless to dream of ramming effectively, since there is no recorded case of the operation having been performed, although it has been attempted at least 32 times. Another is that in such circumstances the rammer stands about the same chance as the rammed does of sustaining non-fatal injuries. Another is that the risks attendant upon ramming are the same whether the attempt be made at sea or in narrow waters. To what extent, it may be pertinent to ask, has the value of the ram as an offensive weapon been modified by the progress of the last 15 years? Will captains be more willing or will they be less willing to use it now, when the nearer they approach to the foe the more fatal will be the foe's quick-firing artillery, and when, at any range up to 800 yds., the effects of a torpedo are to be feared? And why should captains attempt to employ the ram at all when a torpedo, which is far less easy to avoid, and the use of which involves little or no risk to the user, will do all that is necessary? It may be granted that, having first disabled his enemy by gun-fire, a captain may ram with a reasonable probability of success; but in doing so he not only risks dam-



HYDRAULIC CANAL LIFT AT LOUVIERE, SIDE VIEW.

HYDRAULIC CANAL LIFT AT LOUVIERE, FRONT VIEW.

aging his own ship, encountering torpedoes, and bringing about needless loss of life, but adopts a course that leaves comparatively little chance that the enemy, which by other action might be reduced and taken, will ever be added to the effective sea forces of his own country. And, after all, a triumph is only half a triumph unless there be something to show for it. One of the few things that would go toward reconciling Great Britain to the agonies of a naval war would be the occasional spectacle of a foreign battleship brought into Spithead or Plymouth Sound, with the white ensign blowing out above the other flag. That is a sight which would animate the whole Empire, even in its hours of misery. If only on these grounds it seems unwise to destroy your foe when peradventure you can take him alive. And it is scarcely conceivable that a disabled vessel cannot be reduced and made to strike by the combined influence of gun-fire and the threat of the torpedo. I have cited 74 examples of the intentional employment of the ram. In those cases it has in one way or another brought about the loss of 15 ships only, including those which perished by their own act. But the ram unintentionally employed, both in action and in peace-time, has, I am afraid, been much more fatal. To my mind, if I may intrude an opinion by way of making an end, the main lessons of the past on the subject indicate—first, that to endeavor to effectively ram a ship that has sea room and that is under control is hopeless, even if she be of greatly inferior speed ; secondly, that a vessel that cannot be sacrificed ought never to be deliberately employed as a ram ; and, thirdly, that for ramming purposes a little ship is quite as good as a big one. Whether or not this last deduction points to the fact that, with a view to certain eventualities, this country would do well to build a few fast small craft intended for ramming only and of no particular value, I will not presume to say. But upon that point I am specially desirous to learn the views of those who are competent to speak about it.

"The discussion was opened by Admiral Nicholson, who said that the results of Mr. Clowes's investigations must have been somewhat of a surprise. The question of the efficiency of the ram was somewhat late, for the rulers of our own and every other navy had supplied almost all their ships with rams. To what use ought they to be put ? The ram must be looked upon as a last resort, and he doubted whether in action the ram would ever be satisfactory. Excess of speed and also great facility of turning were required for the ram to be efficient. These two qualifications were rarely combined. In the battle of Lissa there were seven intentional attempts to ram. When the bow of a ship was on the broadside of the enemy there was no alternative but to ram. Were naval officers content with the rams of their ships ? The experience of the *Victoria* and the narrow escape of the *Camperdown* were grave object lessons. He would suggest that the rams should be so finely and strongly constructed as to lessen as much as possible the dangers to which experience showed them to be exposed, or that the rams should be separable from the rest of the ship, or that the existing rams should be strengthened so as to make their use less dangerous than it now was.

"Lieutenant Baden-Powell, R.N.R., thought if the ram was so constructed as to drop off grave danger would be incurred if the ram did not fall off. His view was that the ram should be so strong as not to be torn or bent or twisted by the impact. His experience in the Admiralty Court confirmed him in the opinion of the necessity of water-tight bulkheads. Hundreds of ships were by these bulkheads enabled to get to port when their bows were completely crushed. The question was one of construction.

"Admiral Boys knew something of the *Camperdown*, on which he had a son. The danger in that case was not due to her ram, which was uninjured, but from the water-tight doors not being closed in time. He did not believe in the possibility of a removable ram which should not cause weakness to the ship.

"The Chairman said that if he had his way there should be no rams, but a straight up-and-down stem. He agreed also with all that Mr. Baden-Powell had said. The *Arizona's* running into an iceberg with impunity was instructive. If she had been going 8 knots instead of 15 she would have been wrecked. The moral was, if you ram go as fast as possible. The result of the tables in the paper was very curious and instructive. It was strange to find that with ample sea room the rammer was in greater danger than the rammed.

"Mr. Arnold-Forster, M.P., thought that ramming should be confined to specially designed ships. Many of the cases cited by Mr. Clowes were cases of wooden ships. He had tried to get the views of mathematicians as to angles and relative positions of the two ships, but had never received a satisfactory answer. The class of materials used for the ram was an element in the calculation. But he did not think the record against the ram was so serious as the lecturer made out. The case of the *Arizona* was much in point. The ship went on steaming after the collision for several hundred miles. He remembered, too, the case of the *Northampton ;* the rammer escaped unhurt. The *Grosser Kurfürst* and other examples were also in favor of the ram. Ramming was no new thing, but was well known to the Romans and to our own seamen and those of Venice in the Middle Ages. The damage to the *Camperdown* was done above the ram. She did not strike the *Victoria* with the ram alone, but the forward part became entangled with the armament on the *Victoria*. He did not believe in the form of ram-bow. The *Trafalgar* was rammed the other day by a torpedo, and had at once to seek refuge in dock. He agreed with the lecturer that where we had great ships with great guns the ram must not be prematurely used. The most powerful ship was helpless before a torpedo. No naval officer would hesitate to say that ships like the *Polyphemus* were almost as formidable a weapon in war as can be conceived. The ram ought not to be discarded, but employed under proper scientific conditions. In their present form many of our ships with rams were quite unfitted to act as ramming ships.

"Admiral Boys did not agree that a large vessel struck by a torpedo would necessarily be destroyed.

"Mr. Arnold-Forster admitted that he had somewhat overstated the case.

"Captain Barclay said the safest course for a vessel attacked by a torpedo was to be going for the enemy full speed. In those conditions the torpedo was apt to glance on one side. He had seen this result in the case of the *Polyphemus* in 1886.

"Mr. Laird Clowes, in reply, said that the latest battleship built in France—the *Brennus*—had no ram. He had intended to deal with the accidental use of the ram, but found it impossible to do so within due limits. The *Merrimac* did actually drop her ram, but was not prevented from afterward meeting the *Monitor*. The question whether ramming should be at full speed or not was one worthy of consideration. The modern school was in favor of it, but some years ago the idea would have been scouted. Mr. Arnold-Forster's citation of accidental ramming was scarcely to the point. The circumstances of such accidents were widely different from what would prevail in action. His conclusions were, first, that attempted ramming was not dangerous to the vessel attacked when there was plenty of sea room and the latter vessel was under control ; second, that it was always dangerous to the ramming ship and sometimes to its enemy in narrow waters ; third, where the ship rammed is not under control, the operation is not only dangerous, but unnecessary, as the proper course would be to capture the helpless enemy ; fourth, accidental ramming is exceedingly dangerous, and the ram was in fact a weapon more dangerous in peace than in war ; fifth, mere superiority in speed would not insure success to the attacking ship ; and sixth, it was important to bear in mind that foreign countries were building vessels with the special object of using the ram."

STEAM STEERING GEAR.

A STEAM steering gear which is very easily operated and very successful is now being manufactured by Wickes Brothers, of East Saginaw, Mich. It was designed by their mechanical engineer, Mr. Heyde, for use on one of the tugs in the Saginaw River, but has since been applied to other vessels, and will probably find an application on many of the larger steamers. By an examination of the engravings the construction and arrangements of the mechanism will be very readily understood.

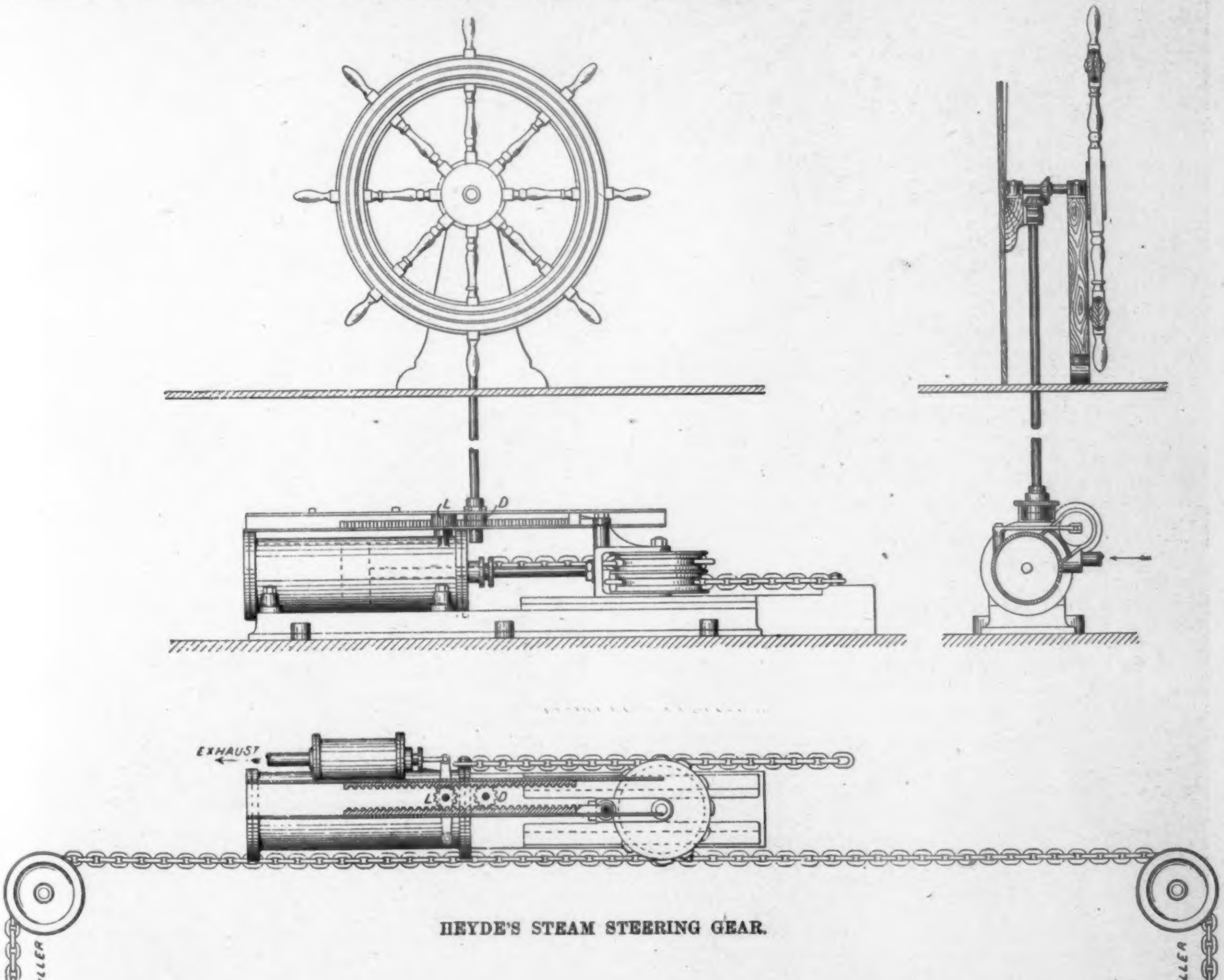
The wheel in the wheel-house carries on its shaft, between the supporting-post and the outer wall, a miter gear which meshes in with another gear on a vertical shaft that extends down to a point below the deck where the steam steering gear is located. The lower end of this shaft carries a small clutch, and below it a spur pinion, which is loose on the shaft, and is furnished with a clutch meshing in with the one already mentioned. Still further below this there is another pinion of the same diameter as the first, but keyed rigidly to the shaft. The sheaves, over which the tiller chains are run, are carried in a strap bolted rigidly to the piston-rod, and these chains, as will be seen by reference to the engraving, are so arranged that, for every foot of motion of the piston-rod 2 ft. of tiller chain are either slackened off or taken in. Over the top of the cylinder there are two racks, one of which is movable and the other is rigidly fastened to a stem carried by the strap of the tiller sheaves, and which moves backward and forward with these sheaves. These racks have teeth, each the width

of the pinions already referred to as being upon the vertical shaft, but the top edge of the movable rack is on a line with the lower edge of the rack attached to the piston-rod, so that the loose clutch pinion meshes in with the rack attached to the sheaves, while the pinion that is rigidly keyed to the shaft meshes in with the movable rack.

The valve is a piston valve especially designed by Mr. Heyde, and detailed illustrations of which we will publish in a future issue, in connection with engines built by the same firm. In this instance this piston-valve takes steam at the center and exhausts at the ends, so that the motion of the valve for admission of steam is contrary to that of the ordinary D-valve, being in a direction opposite to that which it is proposed that the piston shall move. The valve-stem is moved by a rocker arm that is pivoted at one side of the cylinder, and at its central point carries a pinion that has a depth sufficient to mesh in with both a movable rack and the one attached to the piston-rod. If, then, the wheels turn so that the shaft turns in the direction of the motion of the hands of a watch as looking at it on the plan, it will be seen that the first motion is that the lower pinion keyed to the shaft will turn the movable rack to the right. As the piston is practically rigidly fixed in of the cylinder, and thus locks the piston so that the motion is comparatively slight. If it is desired to run the tiller hard over in either direction, it is simply necessary to keep the wheel revolving, so that the motion of the movable rack counteracts that of the rack fastened to the piston. When this is done the pinion on the rocker arm merely revolves and the valve remains in the open position, to which it was carried by the first motion of this rack.

It is impossible to give an idea of the delicacy of the adjustment of this apparatus without an actual inspection of the machine at work. It will readily be seen, of course, that the power required at the wheel is almost infinitesimally small, there being no strain in any way, except to move a perfectly balanced piston-valve, and with the leverage given this is of course almost imperceptible.

An indicator in the wheel-house shows the position of the tiller at all times. Various sizes are made for steamers of different lengths, but owing to the delicacy of adjustments and the direct action obtained, together with the multiplication of the power on the cylinder, these cylinders are very much smaller than those ordinarily used for steam steering gears.

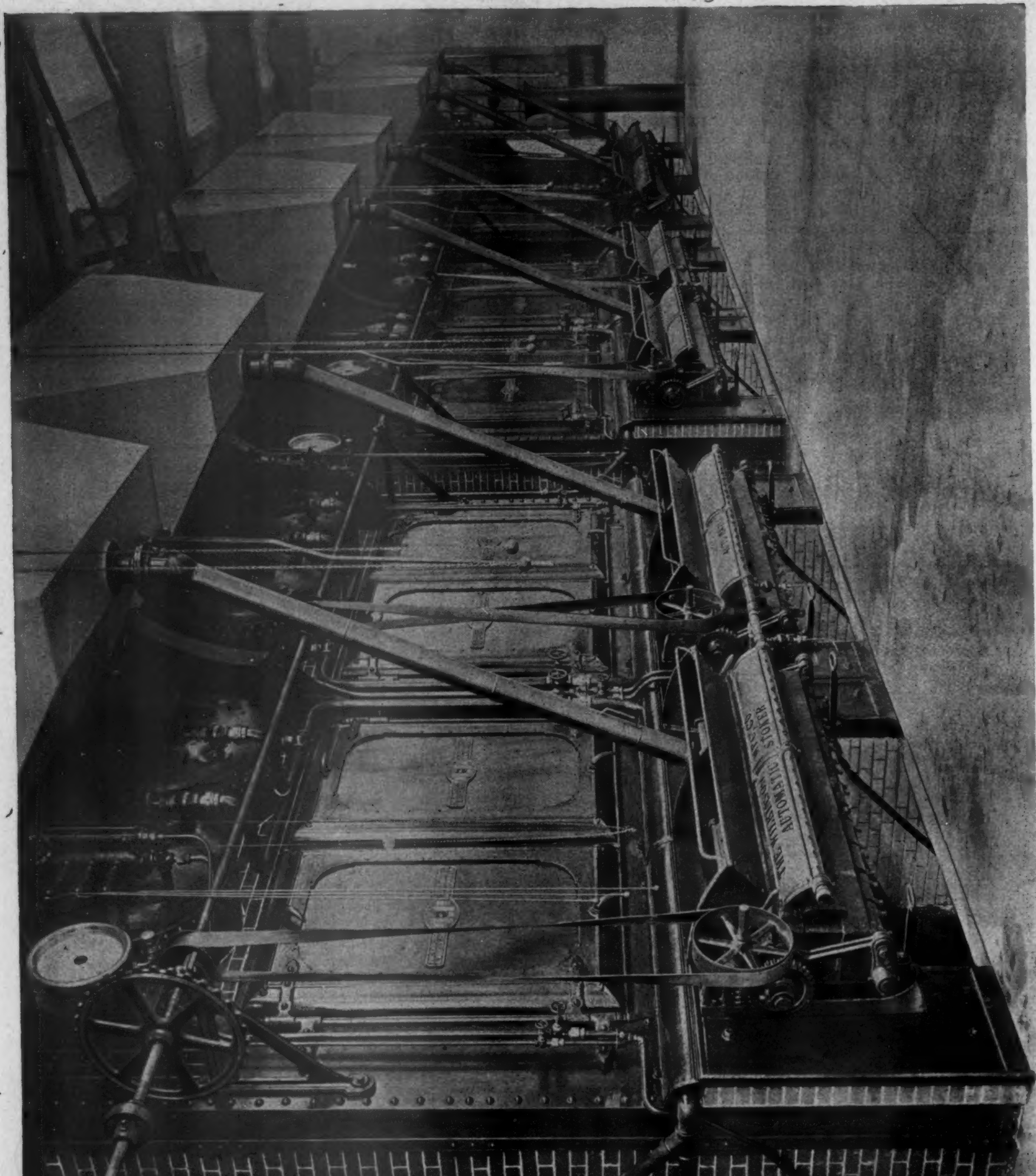


HEYDE'S STEAM STEERING GEAR.

its position, the rack fastened to it is also stationary. Therefore, as the movable rack is carried to the right, it turns the pinion on the rocker-shaft and also carries this rocker-shaft to the right. The valve taking steam at the center position opens the port at the right-hand side and admits steam to the right-hand end of the cylinder. This opens the exhaust from the other end and carries the piston to the left. The first movement of the piston is to draw in the tiller chains, and at the same time it turns the loose pinion on the vertical shaft, until it comes up against the straps of its clutch. At the same time, the vertical shaft being stationary, it holds the movable rack rigidly in position. Therefore, as the piston moves in it rolls the pinion on the rocker arm back with it and closes the valve. The moment the valve is closed steam passes over through a port similar to the Allen port, to the opposite end

BOILERS AND BOILER-ROOM AT THE BALDWIN LOCOMOTIVE WORKS.

The proprietors of this establishment have recently installed a new stationary boiler plant in their works, consisting of a number of Babcock & Wilcox water tube boilers provided with the Wilkinson Manufacturing Company's automatic stoker, appliances for handling coal and ashes automatically, and other improvements which make it one of the most complete boiler plants probably in the country. The boilers are on the second story of the building in which they are housed, which is quite contrary to all preconceived ideas and the old-fashioned principles relating to this subject. In this location there is plenty of light, and the rooms are much better ventilated than they would be on the first floor. The amount of light is



INTERIOR OF BOILER ROOM AT THE BALDWIN LOCOMOTIVE WORKS, EQUIPPED WITH BABCOCK & WILCOX BOILERS.

indicated by the engraving, which was made from a photograph taken in this room without artificial light.

We give a sectional view of the boilers, which have been described so often that no explanation of their construction, other than the engraving, is needed. We expect to give detailed engravings showing the construction of the stoker and other appliances next month.

MEETING OF THE MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

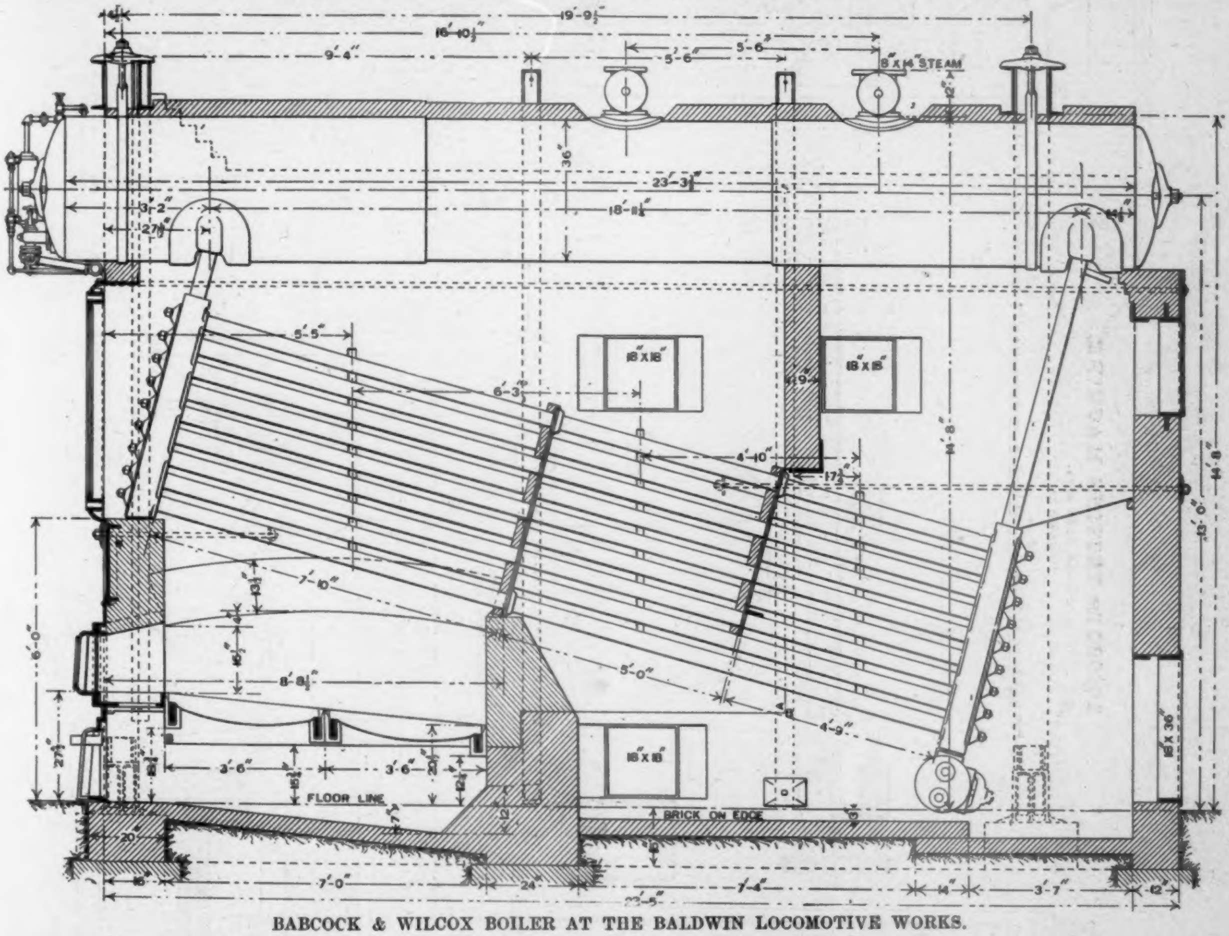
TESTING MACHINES.

The April meeting of the members of the American Society of Mechanical Engineers was held at the house of the Society in New York, on the evening of Wednesday the 11th, with Mr. C. W. Hunt in the chair. The paper of the evening was read by Mr. Tinius Olsen, and related to the recent improvements that have been made in his testing machines. Mr. Olsen spoke as follows:

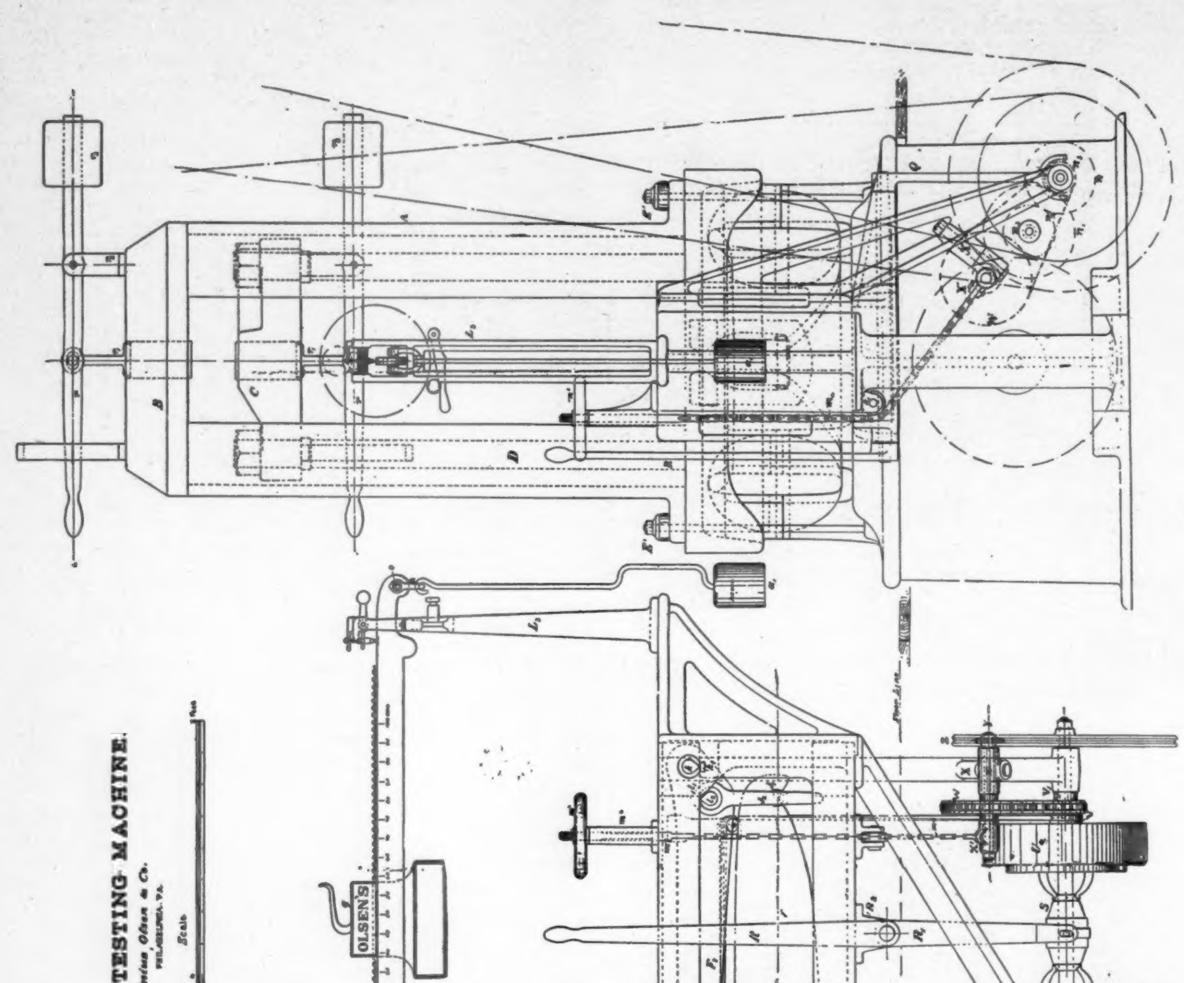
Mr. Chairman and Gentlemen:

The improvements which I more particularly propose to describe to-night will be better understood if the design of the machine to which they are so far applied is shown. Our first view is, therefore, of a machine as it is now very generally used in the rolling mills, steel works and other industrial establishments.

The ends of the specimen to be tested are secured in the cross-heads *B* and *C*, by the wedges operated and placed in the proper position by the balanced lever *r*. The lower movable cross-head *C* is secured to four screw-threaded rods *D*, to which a vertical motion is imparted by a train of gearing in the base of the machine, and the same is operated by power from the countershaft and pulleys *J* and *U*. The upper cross-head *B* rests upon four quarter-section columns *A*, which are supported on the scale platform *E*. Platform *E* rests on the scale levers *F F'*, which communicate the pressure exerted on the platform *E* through the intermediate lever F^2 to the beam where the pressure is balanced and recorded. In many machines the adjustment of the poise *q* is done by the operator turning a hand and cord, or a belt wheel placed in front of the stand L^2. In the view before you, however, the arrangement is shown for the automatic movement of poise *q*, which is now used in many places. The automatic movement is accomplished by a belt driven from the hub of pulley *U* at *V*; this belt runs vertically to and over guide pulleys *Q*, then horizontally to the speed-regulating cones 1^1 and 1^2; from cone 1^1 a small round belt transmits the motion over guide pulleys 1^2 vertically to the pulley *S'*; which turns a shaft in a bracket secured to the beam; the grooved pulley *S'* being so placed that the belt pulls exactly in line with the balancing pivot of the beam, and thus no irregularity in the tension of the belt during the test has any effect whatever on the sensitiveness or operation of the beam. From the pulley and its shaft *S* the motion is further transmitted to a small friction pinion, in the dial casing 3; this friction pinion is in constant motion during the operation of the machine. On top of the beam is seen one-half of a very large pitched screw 4, for moving the poise; this screw is extended into the casing 3, and on the end is secured a large disk and dial, which shows to the operator the smaller and fractional readings of the stress exerted on the specimen. The dial-plate, which is secured to the end of screw 4, is made to revolve by causing contact between it and the constantly running friction pinion, thus turning the screw 4 which moves the poise *q* on the beam. This contact is effected by a lever, one end of which is the bearing for the friction pinion shaft, the other carrying an armature for an electro-magnet at 5, the vibration of the beam, making or breaking the current at 6 for the electro-magnet. When the beam raises, due to additional load, the contact is made, armature attracted, pinion put into gear, and the poise *q* moved forward until the beam descends and the contact is broken; at the same time the contact between the friction pinion and the dial-plate breaks. Thus far, then, we have the machine for recording the amount of stress at which a specimen breaks. There are, however, other points of information about the material tested, which are of just as much or even greater importance for the engineer to know, such as the yielding point,



BABCOCK & WILCOX BOILER AT THE BALDWIN LOCOMOTIVE WORKS.



200000 lbs TESTING MACHINE.
Tinius Olsen & Co.
Philadelphia, Pa.

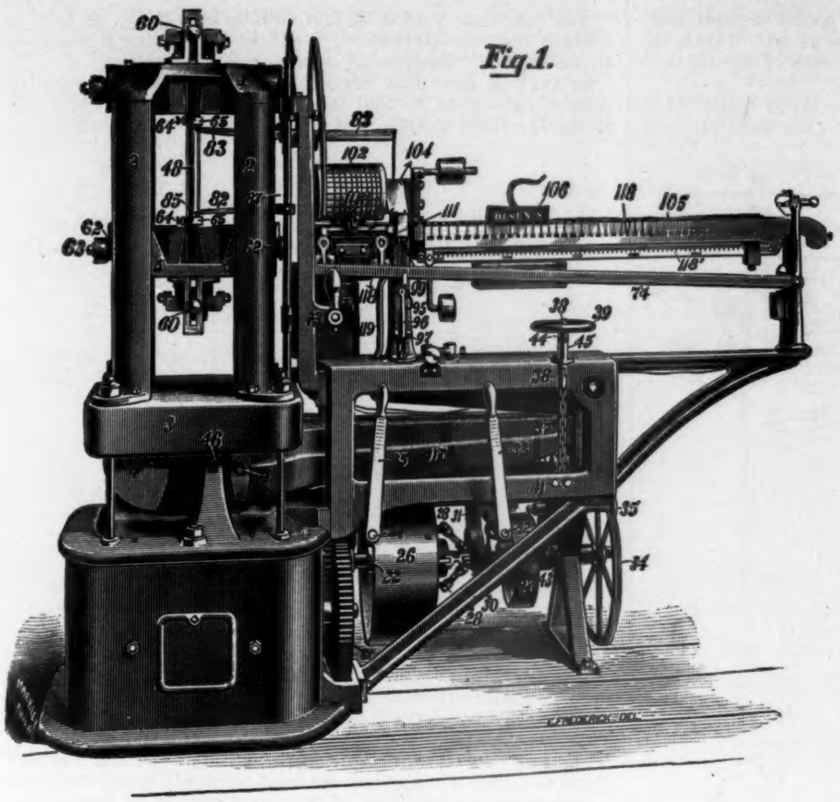


Fig. 1.

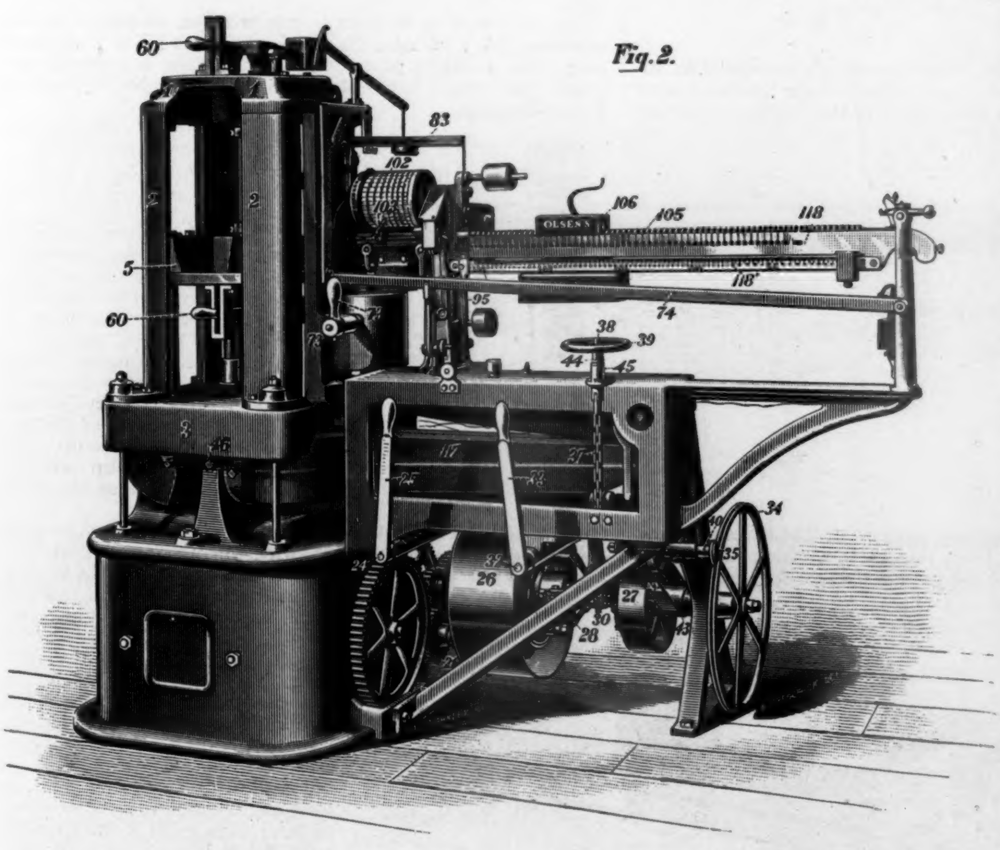


Fig. 2.

and the elongation or the change of dimension of the sample tested. This data, especially the point at which yielding commences, is and has been obtainable in a very crude and unsatisfactory way, and in a great measure has been left entirely to the discretion of the operator, there having been no means for its correct determination for practical use. The drop of the beam, which is used, and is very marked for many soft iron and steel specimens, is for others not so marked, for still other grades and compositions of materials utterly untrustworthy. To make the machine indicate clearly and unmistakably, this point or these points has been my object for many years. About half a dozen different systems for this purpose have been more or less completed but laid aside, not because each system would not work or could not be made to work, and thus in a great measure accomplish the object in view; but mainly because they became too complicated or were too liable to get out of order, or took too much time in its application to be of any practical value. From each attempt, however, some valuable points were gained which finally suggested and helped to develop, not only the best, but the least complicated of them all, and this device seems to be practically all that can be desired for the purpose. It is simple in construction, easy to understand and handle, always ready for use, quick in its application, and not more liable to get out of order than any other part of the machine, as well as of universal use—that is, applicable to the various classes of test.

I will now describe this device. In the illustrations, figs. 1, 2, 3 and 4, the reference marks correspond. On top of the beam is mounted the cylinder or drum 102, which can revolve on its axis; to this drum is attached a sheet of paper, on which the object is to have the mechanism trace a diagram or curve line, which will at the same time show both the stress and the amount of yielding of the specimen.

A pencil at 103 traverses the drum and paper in the direction of its axis; it is moved by the same screw which moves the poise 106, consequently any movement of poise also imparts to the pencil a corresponding amount of motion in the direction of the drum's axis; these distances form the ordinates to the traced curve and represent the stresses.

The other motion necessary to trace the line forming the curve, which will be the abscissæ representing the yielding of the specimen, and is accomplished by revolving the drum corresponding to such yielding.

This yielding motion of the specimen is transmitted to the drum as follows: Starting at the specimen 48, fig. 1, two collars 64 are placed upon it at a certain distance apart, say 8 in., as now generally adopted.

On the under side of the upper collar 64 are fingers 83, one on each side of the specimen, so arranged that they will transmit the central motion of the specimen to the arm 83, arm 83 being pivoted for vertical motion at 88, fig. 4; any vertical motion of the specimen or upper collar is thus transmitted to

point 101, then further communicated by a cord or steel band to one end of the lever 97, which is pivoted at 98. This lever 97 is placed in a vertical plane under the edge of the balancing pivot of the beam.

Starting again at the specimen, on the lower collar 64 is placed another pair of fingers 82, which, in the same manner as the upper fingers, transmit any vertical motion of the specimen to the vertical rod 87, figs. 1, 3 and 4. The lower fingers 82 can be adjusted anywhere along the vertical rod 87, so as to be in proper place for the length of specimen operated upon.

The vertical rod is attached by a pivot to one end of the bar 74; the other end is supported on a pivot at 50, and, at a point 99 on this bar in the vertical plane of the balancing pivot of the beam, is attached a band or cord 95, which first runs down and over a pulley 96 in the end of the lever 97, then up and over the guide pulley 99 to the enlarged part of the shaft 100 for the recording drum. Thus the vertical motion of the specimen or the lower collar 64, on the specimen, is communicated to the recording drum, imparting motion to it, or allowing same to turn on its axis.

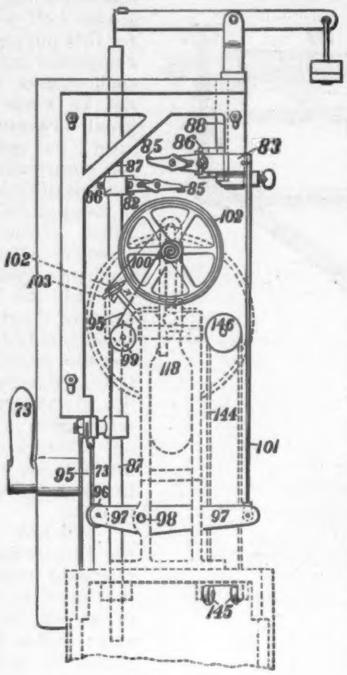


Fig. 3.

The function of lever 97, whose one end is connected to the fingers resting against the upper collar on the specimen, and the other end in which is the pulley, to the fingers resting on the lower collar, is, to separate the motion that takes place by the specimen as a whole, from that motion which takes place in it and only between the collars, or to retain for transmission to the recording drum, only what may be termed a difference of motion, the motion taking place either in or by the heads of the specimen, not being transmitted to the drum.

The function of lever 52 and counterweight 53, fig. 3, is to balance the whole system of parts, so as to make it sensitive to the smallest variations of motion.

In fig. 5 is shown an arrangement of adjustable heads for parallel specimens, as well as a device for placing these heads on the specimen quickly and in the desired proper position.

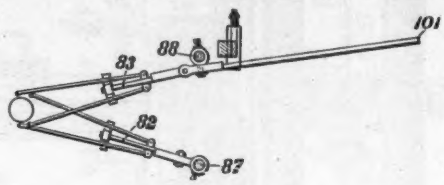


Fig. 4.

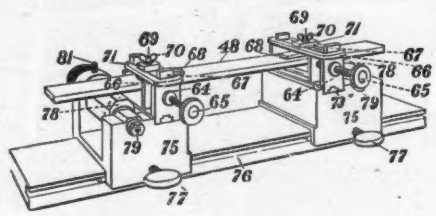


Fig. 5.

The next three figures show this arrangement very plainly, the two at the top being two different kinds of heads, and the lower figure the setting device with the specimen and the heads on the same, ready to be placed in the machine.

Having now shown and described the device and the machine to which it is applied, the next view will show diagrams as traced in the machine. The upper card is of tensile diagrams, No. 1 and 2 of steel shafting, No. 3 of steel boiler plate.

The next card is of tests in compression, as traced on the machine, No. 1 of ash; No. 2 of white oak; No. 3 of hemlock; No. 4, white pine; No. 5, brick; No. 6, a punch diagram, $\frac{3}{4}$ in. punch through $\frac{1}{2}$ in. steel plate; No. 7, another punch diagram.

The lower card contains diagrams of transverse tests, No. 1 of wrought iron; No. 2, general foundry iron; Nos. 3 and 4 of pig iron.

In this last view given is shown a wire-testing machine, just recently designed and finished, in which the graphical system, as before described, is considerably altered and modified. Having for some time had much inquiry for wire-testers that would test quickly, as well as furnish more data of the test than those hitherto in use, this subject was taken up and resulted in a machine as the view represents.

In this design the automatic operation of the beam enables the operator to do more than twice the amount of work performed on previous machines in the same time. In the graphical arrangement, which in this machine you will notice to the right, the diagram paper is placed on an inclined table in front of the operator. The tracing of the pencil in this case, when such quick work is calculated to be done, will be used mostly for notifying the operator when to read the figures on the beam for the yielding point, as well as for quick reading of elongation; as no mark is put upon the wire before it is placed in the machine, the elongation is taken from the card, which is the distance traveled by the pencil in the direction of the abscissæ. The full test covering the yielding point, elongation and ultimate strength can be obtained on this machine in less time than it takes in the older machines simply to arrive at the ultimate strength of the wire.

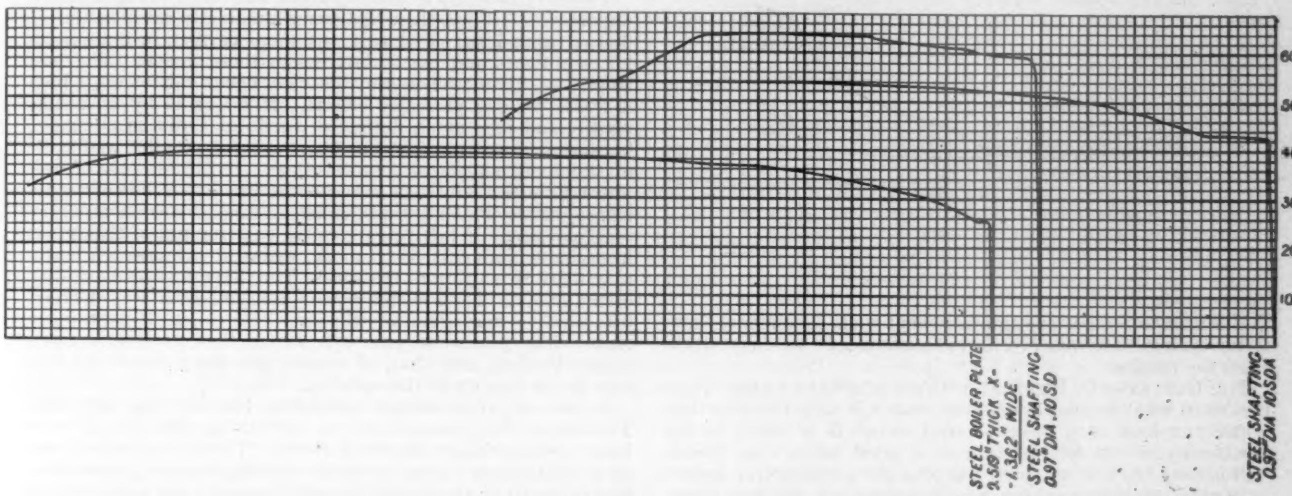
I will not go more at length into the details of this machine, nor into the further extension of the system we are just perfecting, and which promises well for a still greater refinement, which in time it will easily cover—that is, in reference to the line within the elastic limit for tensile and compression tests. The time for preparation was too short, and it would also have taken too much of your time this evening.

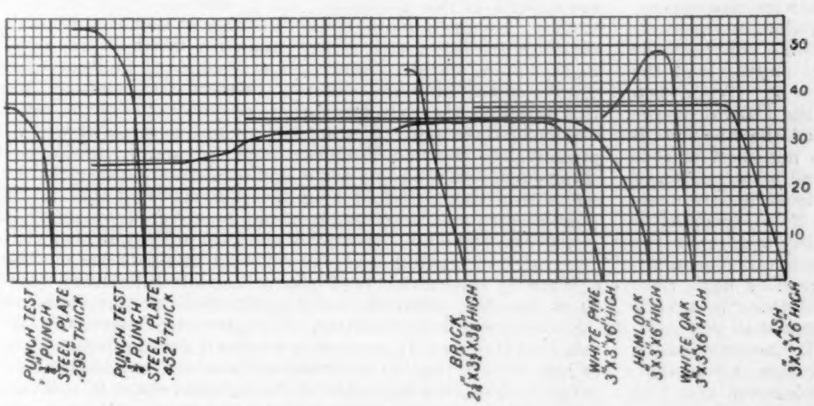
DISCUSSION.

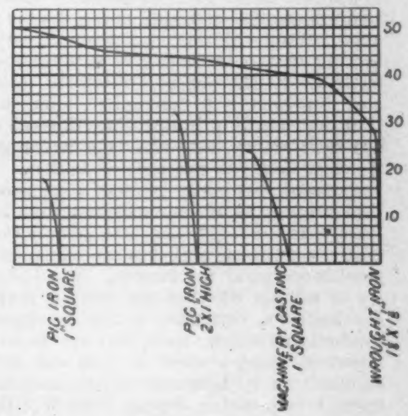
The discussion was opened by the reading of two communications which are here presented, although the first does not relate to the topic of the evening.

FROM D. L. BARNES.

I enclose a diagram which I would like to have discussed; it relates to compression in steam-engines.







The point in dispute is, What is the proper amount of compression in engines having considerable clearance, especially locomotives?

It is almost universally believed by locomotive builders, and to some extent claimed by stationary engine builders, that compression should be carried up to the admission pressure.

Professor J. Burkitt Webb, in a paper before the American Association for the Advancement of Science, has described the proper point of compression to be the point B on the diagram, where the area $A\ B\ C$ is equal to the area $D\ E\ F$. This plan does not take into consideration the loss resulting from the heating up of the metal surrounding the clearance spaces during compression. In some engines the heat that is taken from the compressed steam in this way is considerable, especially in locomotives, where the cylinder-heads are badly insulated.

The diagram with this shows a case of this kind, where the actual compression line $G\ B$ falls below the line of equal steam weight $G\ H$.

It is certainly more economical to heat up the metal surrounding the clearance spaces by steam, taken directly from the steam-chest, than extract work from the momentum of the engine to heat up these surfaces, and therefore in engines where the actual compression line is much below the line $G\ H$, of equal steam weight, the most economical point of compression is below the point B.

In engines having steam jackets, or where the steam chest is placed on the cylinder-head, as in the case of the Westinghouse engine, the actual compression line rises above the curve $G\ H$, and in such engines is not the most economical point of compression above the point B?

FROM E. D. ESTRADA.

As it will be impossible for me to attend the meeting of April 11, when the subject of "Testing Machines and Tests of Materials" will be discussed by the members of the Society, I avail myself of the invitation issued by the Committee, and submit herewith the following remarks, trusting you will kindly read them to the members present.

There is no subject in engineering which has such an extent of unexplored ground as that relating to the resistance of the materials used in engineering construction.

Our present knowledge of the subject is based on the results of experiments devoid of any scientific value, notwithstanding that some text-book authors and experts affirm the contrary.

What scientific value, for instance, can a determination of the "elastic limit" have, when, in the first place, we do not know what it is (see text-books on the resistance of materials), and, in the second place, we have no standard method of determining it?

The lack of a standard method of testing, a standard form of specimen, and a standard unit of measurement, is the cause of much mystery in this branch of our profession.

There are some of you, no doubt, who believe that the ultimate tensile strength of wrought iron and steel is increased by straining the material permanently, and then allowing it to rest.

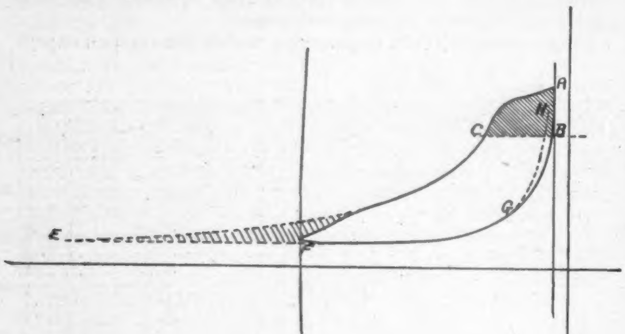
Experiments have been made, and to some minds it has been shown conclusively that such is the case. But let us ask the question, Were the conditions under which the specimens were permanently strained and then allowed to rest the same as those under which they were finally broken? We are left

without an answer. How can we then attribute the increase in ultimate strength to rest?

It is, indeed, lamentable to acknowledge that, if any new steps have been taken for the purpose of determining the physical properties of iron and steel, they have been directed in a new path, leading backward rather than forward.

The time when a test specimen was required to have opposite sides parallel is rapidly passing by, and to-day we find some of our most distinguished inspecting engineers accepting, without a murmur, such tension specimens as are shown in the enclosed sketch.

These are not exceptions; similar ones are tested here every day by the hundreds, and who knows but some of the results thus obtained have gone to form part of experimental data in the establishment of principles.



If a man is foolish enough to accept such specimens, there is no telling how many different conclusions he may draw from the results.

MR. GUSTAVUS C. HENNING: There is always a great question as to what is good boiler steel, and it is very peculiar that when you look at a piece of steel, when it is tested in the machine, you can tell whether it is good boiler steel which will behave well in a boiler, particularly a locomotive boiler, by a very peculiar marking which appears on the test piece. It appears in the form of peculiar striations somewhat similar to double cross-hatchings, and gives the metal a mottled appearance. You will also find a lot of very peculiar marks intersecting at the same angles throughout. Some call that the skeleton of the steel. Of course it is not anything of the sort, but that is a convenient name to give it. When you find that marking in open-hearth steel and the general factors are satisfactory, you can take it for granted that the steel is the best that you can get foı boilers. I do not know what is the reason, but many years of experience and investigation of that subject have demonstrated that invariably boilers made from that steel give the best satisfaction. If the specimen is entirely uniform and has no markings of any kind, then the steel is not good for boilers. Then there is another peculiarity in telling whether the steel is really good or not. Say, for instance, you have a flat specimen; if there is a very gradual reduction, then that specimen shows that you have about as good a steel as you can get. If the steel has a shoulder in it, however slight, and then comes down, then there is something wrong with it. But whenever you find that in a test piece, you can say that the steel is undesirable. That is shown by this test piece (showing a specimen).

I also have a piece of a car axle that had been running in service for some time, until finally it broke. On this piece you will see the successive fractures. Most car axles do not break at once, but they break sometimes six months before the axle will be so defective that it will have to be thrown out of service. But each of these rings shows a successive fracture.

MR. J. SELLERS BANCROFT: That same appearance is frequently noticed in shafting.

MR. HENNING: Fractures of axles are probably caused more commonly by bad frogs and running over switches than anything else, unless you have a very hard bed lying on a solid rock, and you carry heavy loads over it.

Here is what some people sell for the very best boiler steel, which gives all the ductility and everything else you want, and when you come to look at it, it is nothing but a couple of pieces of wrought iron and steel welded together—that is, they are put in a furnace and piled, just the same as you pile wrought iron plate, and submitted to extra high heat, and then rolled out together. The result is that the material is unreliable, and when you least expect there is trouble with it.

PROFESSOR HUTTON: Mr. Henning says that a specimen not showing those skeleton marks is undesirable for boilers. In what way does it show afterward in service that it is not a good steel?

MR. HENNING: It will break and crack, and apparently become what they call mushy or honeycombed. It will simply go to pieces if you keep it in long enough. Here is another specimen which is a pretty good illustration of a good fracture, which is the common thing in the better class of steel. There is a theory that says that when material breaks it always breaks on a given plane, and that this angle determines the quality of the material—that is, from this angle you can determine the resistance of the material. Now, in the case of steel, that fracture might be on either side, because it is very good steel, very uniform. The result is that it will not be a sheared surface, but one piece will be a truncated cone and the other piece will be the corresponding cup. I have never seen any practical use made of that theory, that the angle of shear is the characteristic feature from which you can determine the properties of the steel.

I would like to say something about Mr. Olsen's diagramming apparatus. I think these diagrams are really remarkable. I do not think I have ever seen any more correct, or more regular than these, and particularly so in these woods. They are simply beautiful. You see this shows that this wood, which is white pine, is perfectly elastic. Hemlock is by no means elastic, and it is not a desirable wood for building purposes, because it is so irregular, the fibers are not parallel, and some of the fibers may break before others; but in the case of oak you will notice how very straight the line is. There are some irregularities which I think must be due to some temporary derangement. When you get to the extreme test of that wood it becomes suddenly very weak, while in the case of white pine there is nothing of the sort. You have a gradual sliding of the fibers. Then in this case of ash you see a very decided break and a very good elastic line. Of course it is stronger than white pine, but you will notice that its line is more nearly vertical, and that, of course, is a very important feature in the quality of the material.

In the case of these steel specimens, they are also very fine. The steel boiler plate shows the very thing that Mr. Estrada said we do not know anything about. There is a straight line up to that point. Unfortunately this diagramming apparatus, as well as all of the others, does not magnify the elastic curve sufficiently. All the properties for which we use materials are defined in this particular, and if this line were drawn to such a scale as to magnify this distance a thousand times instead of five times, as it is here, then the width of this pencil mark would, on this diagram, be at least 4 in., and you could draw as many lines and different lines in that, running from this point to the extreme corner, as you could draw pencil marks in these 4 in. I pointed that out in a paper which I presented to the San Francisco meeting, and I drew one of these curves on a tenfold scale, and on a different sheet I drew one with a thousand-fold magnification, showing that all the possible errors of observation would be covered by the finest pencil line you could draw, while all the distinguishing characteristics of treating steel by different methods are entirely covered by this thickness of pencil line, and this curve would show nothing, while if the magnification were a thousand times, every different method of treatment of steel, whether you heat it or cool it, or heat it suddenly or cool it suddenly, or heat it uniformly to a certain temperature or a higher temperature, would be indicated by the different shape of this line, whether it be more nearly straight or less so, and especially where the elastic limit is located. Mr. Estrada said you could not well define the elastic limit; but up there you will notice just at the top of that shade where the line deflects, that is the elastic limit, and where it shoots over to the left, that is the yield point. Where the proportionality of extension changes, that is the elastic limit, and where the proportionality ceases and there is a continued stretch without any appreciable increment of loading, that is the yield point. Those points are very well defined, and nothing will characterize those points in material as well as a diagram. Then, on the other end of these curves you will see that there is the maximum load, and then beyond that the testing machine is sufficiently good to let the weight run back until the specimen breaks at a load very much less than that carried before; especially in the case of this steel casting here. That, Mr. Olsen says, was cold rolled, showing how cold rolling affects the properties of the steel. The testing machine allows the weight to run back on the beam, which is very prettily shown there, and the specimen breaks at a much lower load than it carried before. On the other hand, you will notice that we have no indication there that the two pieces of steel have been treated any differently; while if that elastic line were drawn with a thousand-fold magnification, it would show a

very marked change from what you see on the diagram there, and would really be characteristic of the treatment to which the material had been subjected. I hope that the diagramming apparatus will be so worked out that we will get one that will draw nothing but the elastic curve, and this on a very much magnified scale, when we can simply have a diagram of that sort, and from the mere appearance of that diagram determine what treatment the material had been subjected to. Of course I do not mean to say that a diagram, except in very rare cases, can be used to measure off elongations or loads unless you have made all possible corrections for errors of instrument, and temperature, and what not; but at least the shape of the curve would be undoubtedly of most valuable assistance in determining the particular influence of the treatment to which the material may have been subjected.

Mr. J. Sellers Bancroft: I might say that we have been working on a recording apparatus to meet this thing which Mr. Henning speaks of. We have made a number of experiments, and it looks as though we should succeed in accomplishing something; but we have not got it ready to talk about it. We have it magnified on a scale of a little over a thousand times. I believe that diagrams before the yield point is the point we have to look to.

Mr. Henning: In regard to the diagramming apparatus, I would say that the prettiest thing I have ever seen is a photographic apparatus designed and used by Professor Marten, of Berlin. He simply throws a ray of light from a little mirror on a sensitized film. The room is dark except for that ray of light, and having the mirror move in one direction by the motion of the weight, the position of which determines the load on the specimen, and the revolution of this very small mirror throwing the beam of light across the sensitized film, draws, photographically, diagrams just like these, and he can magnify them as much as he likes, because it is only a question of casting the ray of light through a lens on a more or less distant screen. Afterward he develops them, and he has obtained some very beautiful results. Another thing he does is rather unique. He makes a diagram of these minute extensions. These extensions within elastic limit are less than .01 of an inch actual measurement. He has a little apparatus consisting of a movable glass weight, and the specimen moves a diamond point. That diamond point engraves a fine line on the glass, and it is so small that the head of a pin will more than cover the whole diagram. Then he puts that in his lens and projects it on a screen. When thrown on a screen and compared with the observations of other instruments the results are comparable; but it is remarkable how you can make a microscopic picture like this and throw it on a screen and check up your results. Of course he did not intend to check up his results by that diagram, but the diagram was sufficiently good to do it. He uses that only when he tests small objects, such as paper or silks. He has not used it for structural purposes. I would like to pass this around and then call attention to what it is. This is a 2-in. specimen; this is an 8-in. specimen; that a 6-in. specimen; that a 4-in. specimen. It is always a question how much does that material extend. If material is uniform, the extension should be the same. Take the elongation as measured between the unloaded condition of the test piece and the maximum load, and you will find that the percentage of elongation up to that point is always uniform, whether you test a piece 2 ft., 10 ft., or 20 ft. It is quite independent of the shoulders or length of the specimen or anything. This point indicates that a test piece which was reducing perfectly uniform is endeavoring to neck down or have a reduction, as they call it, and finally the fracture generally occurs in there (indicating) just as that little circular piece shows. We generally measure the elongation by taking it between two marks that I made here, and including local elongation in that, and after having observed that—of course, that is observed after you take the test piece out of the machine—then if, by calculation, shown in Report No. 4 of the Society's Committee, you deduct the total elongation from the local elongation, you will get the percentage of elongation. It is very difficult to work out the exact proportionality. In that 2-in. test piece we may have 50 per cent. elongation, because the 2 in. in here elongate vastly more than the rest; but the length of the specimen has a great influence on the recorded percentage of elongation. That, of course, vitiates statements of elongation of material, unless you are told on how long a specimen the elongation was measured. But these photographs are photographs of pieces that were tested that way, and in every case the proportional elongation is identical, whether the piece is 2 in., 4 in., 6 in., 8 in., 10 in., or anything. The elongation in this case runs from 22 per cent. up to 43.7 per cent., while when you take a correct observation, the actual elongation of that material is a little over 25 per cent. in every case.

Mr. Brinckerhoff: I would like to ask if the cross-hatched appearance on the faulty steel is supposed to be due to the same cause as the cup on the round steel.

Mr. Henning: I do not think it is anything like it at all. This is something that never has been determined, and we cannot find out at all why. That skeleton has been cut out and analyzed chemically, and you cannot find any difference between that and the remaining material. We simply know from thousands and thousands of tests that have been made in the same way that the material that shows marking is always the best material for boilers, and that when the material does not show it it is not good for boilers.

Mr. M. N. Forney: In this connection I will call attention to what has been observed in the punching of fire-box plates for locomotives. Mr. William S. Hudson, formerly the Superintendent of the Rogers Locomotive Works, first called attention to it. I will exaggerate it somewhat, so that the members can see it (referring to a sketch). In punching the holes for the stay-bolts in locomotive fire-box plates, Mr. Hudson observed markings somewhat of that shape—curved lines which radiate from the hole all the way round. Now, the curious fact was that there was another series of rings which radiated in the reverse direction. It is very much like the milling work on a watch-case. I never heard that any relation was observed between the quality of the steel and those markings. I think that all the conclusion Mr. Hudson came to was simply like the old lady's theory about indigo. When she put it in water, it would sink if it was good, or it would sink if it was bad—she didn't know which.

Mr. Henning: When you drop a plate on edge on a heavy body you will get them. They are simply lines of intersection of stress. If you hit a plate with a hammer you will get those marks. The stress, of course, radiates from this point. There are lines of pressure outward in every direction, and, of course, there are resisting lines in the other direction. When you plot all these curves and all these lines of stress, and the diagonals of these lines of stress between the resistance of the material and the lines of stress, you will find intersection of these lines, and when you make a sufficient number of them you will find that you will get these curves. They are nothing but the intersection. Instead of having one intersection, suppose you take a number and through all these you pass other lines, the scale will not break except at the intersection of these two lines of force, because there the material is displaced locally, and the scale will crack off there and leave these wide lines which simply indicate the intersections of the lines of stress. You will find it in every case when you strike a piece of steel, so long as you strike it hard enough to break the scale.

Professor De Volsen Wood: I may be pardoned for saying, in regard to these lines that have been indicated by Mr. Henning as lines of stress, that Rankine, when he diagrammed them, called them lines of shear. They were shearing stresses, and they were conjugate at that; but I was wondering why those were curves in the case of punch plates, and I have not satisfied myself theoretically why they should be curved. It is a good thing to have the fact independent of the theory. I once had a conversation with Mr. Lavan, a celebrated Canadian ventilator of buildings, and I told him that I had tried his system in my private house. I let the air in at the top and made a place for it to go out at the base on the opposite side, and the air would go right across instead of diffusing itself into the room. "Professor," he said, "it is contrary to theory." He had the theory and I had the fact. So I am pleased to get the fact in regard to this curve.

Mr. Bancroft: We made some diagrams some years ago of the force required to punch, which resulted in a rather different diagram from that shown by Mr. Olsen, simply because the material, I suppose, was very much thicker relatively to the diameter of the punch. The thickness of the plate was very nearly equal to the diameter of the hole, and the pressure ran up very rapidly—reached a maximum when the metal was starting, then it fell off to about five-eighths of the total height, there being a perceptible amount of pressure required up to the very last moment. A flat punch was used.

Mr. Henning: You can reproduce similar lines by simply vibrating a plate and throwing sand on it. If you take the proper plate and the proper force you can arrange lines almost identical with these. If you take a plate of glass with a hole through the center and make the plate vibrate, I think you will get those identical lines in fine sand. I think you can reproduce those lines exactly by means of a plate of glass, showing that in circular lines where the stresses intersect you will get an effect, and where the stresses do not intersect you will get no effect. Where the glass plate remains quiet the sand will gather; where the glass plate has any motion there will be no sand. When the lines of force intersect, they will neu-

tralize one another and the sand will remain there, but where the glass is all in vibration there will be no sand.

You can find these curves for a great thickness in the metal. I do not know how deep they go. I should judge they would go all the way through, just the same as when you take a die and stamp a plate of steel with it, or when you cast a name on cast iron and take it off. If you put some acid on it that whole name will come out perfectly plain. If you take that same material and polish it and do everything you can, the mark will still be there and that can be found a quarter of an inch deep. If you mark a letter on a steel plate where you have uniform material, you can try to remove that, and no matter how much you try, it will always come out again, especially if you use a little acid and etch it. I know that people have taken other people's patterns and taken castings off them, and they would simply chip off the names, and afterward, if you want to find if that casting had been made from such pattern, all you have to do is to polish that up and etch it a little bit, and the whole name will come out as plain as if you had painted the name on.

MR. MITCHELL: I would like to ask regarding the speed at which a testing machine should run. I talked with one or two members of the Association before the meeting, and I could not get any light on the subject. It is a fact that you can get different results according to the different speeds at which you run a machine. If a plate is tested on a certain machine, it will give us results like the specification; if tested on another machine at different speeds, we will get different results. We will accept the material on the test given on one machine, and on the other we will condemn it. I refer to the speed at which the piece is tested. The higher the speed, the better the tensile strain. I was educated on a Riehle machine designed by Mr. Olsen. It was the first machine the Pennsylvania Railroad had, and I worked that machine for 14 months. I tested over 9,000 samples. The speed was 1 in. in three minutes, and that is the speed at which I always tried to run the machine. I have, however, never tested the same machine at different speeds.

MR. HENNING: If you test soft steel, especially basic steel, it does not make any difference what speed you test it within your capacity of observing anything about the test. Of course it is well known that in the Carnegie Works they test so fast that you simply take the man's word for it that it carried that much; but if you know your business you do not let them run a machine rapidly. There is a reason why the machine should show higher results when run very fast, and that is so much momentum is applied through the test piece to the beam, which is of considerable mass, that it will always keep carrying more. When you come to a rest the machine balances all right. But as you keep on running the weight is always ahead of the load you have on the test piece, and the faster you run the further the weight will be ahead of the load, in order to counteract the momentum due to the increase of the force applied. If you apply the same force, the momentum in the beam will be the same. There is always an increase of force applied. Hence, there is always an increase of momentum, which must always be counterbalanced by a slightly advanced position of the weight. But if you run as fast as 2 in. in one minute, on the ordinary soft steels, you will not find any difference. When you test boiler steels which have different qualities altogether from the soft steels, there you find considerable difference. There is a difference between the acid and the basic steels. The acid steel always has more carbon than the basic. You can run the Emery machine as fast as you please. Of course it takes the greatest skill to keep the Emery indicator floating between the marks; but so long as that indicator floats between the marks, you have always got the indicated load on the piece. If the machine is running so fast that you cannot observe every point about it, it is going too fast. I simply see how the machine behaves, and if it behaves well, I let them run a little faster. When the machine is a doubtful one I run very slowly, until I find out what the machine is. When I want to know what results I get out of a machine, I calibrate the machine. If you do not do that you do not know what the material stood.

PROFESSOR HUTTON: I think there is more in that subject that Mr. Mitchell has opened than Mr. Henning fully covers, while his explanation is of real value. I remember a case which came under my own observation not long since, where a firm in town here wanted to send some copper for fire-boxes to the Baldwin Locomotive Works, who were going to send some furnaces to South America, where they have a fondness for copper. They wanted some unprejudiced party to say what the copper would do. The requirement was stretch, 25 per cent., and tensile strength, 35,000 lbs. They asked me what kind of sample I wanted to test. I said, Give me at least 4 in. of reduced section taken from the ½ in. plate. We were running at that time on the old Fairbanks screw machine, and I found it impossible to give that 35,000 lbs., but I could give them 35 per cent. to 40 per cent. stretch right along, but we could not raise the tensile strength higher than 33,000 lbs. I finally told these gentlemen that I thought the Fairbanks machine was not the one to test this piece on, because those people down there are used to a hydraulic machine. So they took the specimen down to the Post Office and got Mr. Starbuck to test it, and got the test all right. I could not absolutely get it in any way on the old Fairbanks machine. The specifications were based on a hydraulic machine. There is something in the material itself and in the fact that if you will put a load on past the elastic limit, you can leave the load of the elastic limit of a material like copper and simply pull it out, and simply by putting on a little additional strain every day, the thing will ultimately break. There is something, I am sure, in the speed besides this mere inertia of the beam, which of course does enter as a problem when two tests are made at nearly the same speed; but where there is a great difference in the speed I think the material comes in.

MR. HENNING: What I said applies only to steels. Professor Hutton is perfectly right, when you apply it to certain grades of steel, as manganese steel, or to Tobin bronze, or copper. The shape of the test piece also has proportionally greater influence on the results obtained than the treatments to which the material might have been subjected, in order to have produced certain results; but in the case of alloys and coppers, you have to be very careful about using the proper speed, and giving the material time to arrange itself. Of course that higher tensile strength is only fictitious. That is an artificial advantage which you would not find in service in a boiler. They would simply break at a lower load, if the load ever got to that point.

I heard from a gentleman in Pittsburgh to-day, who wanted to come here to speak on this very subject, but who did not get his invitation in time to be present, and he asked me to refer to it if no one else did. If you test material immediately after it comes from the rolls, the material will be decidedly weaker than if you keep it lying idle from 12 to 24 hours. Our better rolling mills never give you a piece, especially thin shapes of plate or small bars, that have not had a chance to recover after being rolled. If you take a sample from a plate as it comes from the roll it will not give the ultimate strength, nor will it show the elastic limit or elongation within a very considerable amount. So it is often a question of rejection or acceptance, whether you allow the material to rest awhile before you test it or whether you test it fresh from the rolls. About the benefit of giving the material rest after having done work, I do not think that ought to come into account with engineers, for the reason that we are not supposed to use material that way. It is a well-known fact that when you strain material and then let it stand, instead of giving you the normal curve, you find it varying at a point lower down; but at the point where the rate of proportionality of elongation changes, would probably have been changed slightly after starting up again, and then the yield point would have been augmented. Now, if you carry this on several times you would always get a little offset with a little higher elastic limit. It would remain there afterward, but you see you have hurt material. You never use the material in structural work, except below the elastic limit. When you take material that has an elastic limit of 30,000 lbs. and load it to 15,000 lbs., you are exceeding the working load you are allowed to put on material. In testing material and taking a diagram to this point and stopping here, the material will stretch a little bit if it is soft material. Just as soon as you begin again to reload the test piece, a line, parallel to this extension line, will be produced and the resistance of the material is increased until you rise above the maximum, and you can increase it so that ultimately it will not break off at the normal point, but it will break off far short of it; hence, though I have not got enough data to prove it, I think you will find that when you get the whole area in the modified diagram, it will be less than the original area that you would have obtained if you took it within the natural curve, showing that the material, although it shows a higher load or a higher elastic limit, is inferior. Of course the main point is to determine the material in the conditions in which you intend to use it.

PROFESSOR WOOD: I have seen tests made under the conditions now referred to, where the piece was partly broken, and then, when allowed to rest, either with the stress on or with it removed, when the stress was renewed the elastic limit was raised, as Mr. Henning has said, that it becomes less durable. The elastic limit may be raised in that way, and the failing point also raised. I acknowledge that this fact was an interesting one to me, if not a profitable one by way of instruction. Before this was known I felt fearful of

the hydraulic method of testing boilers, that by applying a stress larger than that which it was intended to carry, the material might actually be injured; but after this discovery was made I saw it was a good thing. The material was not injured. It would stand a stress from steam without failure greater than it would if the steam pressure had been applied the first time without that stress, and although the material should not, as Mr. Henning has said, be used to any such an extent, yet it is sometimes, under exceptional conditions. In the case of steam, the pressure does sometimes run up much beyond what was intended. However, whether it be so or not, we cannot study the properties of materials too carefully and learn what results from all kinds of stresses both within and beyond the elastic limit. I was not displeased to hear, as I came into the room, some remark in regard to our not knowing anything about the elastic limit. It reminded me of a remark made to myself by an engineer. He said, "You talk about the factor of safety. The factor of safety in these days of science and knowledge! I call it the factor of ignorance." That just covered it exactly. I did not care for the term, but it was a correct one, and he would have us understand that we ought to determine exactly the conditions of things in regard to the materials used in construction. We do know, from long observation and experience, that there is a general, if not a very specific relation, between the so-called elastic limit and the ultimate strength. If the strength is 60,000 lbs., the elastic limit may be nearly 30,000 lbs., so that we have a factor of one-half for the first one, and as an approximation toward what we may use; but there comes in our ignorance. We do not know exactly where the elastic limit is, and, as already stated, the ultimate strength depends on the manner in which the piece is broken. That only shows us that as experiments go on, and as our knowledge becomes more and more definite, that the manner of breaking a piece becomes an important element. Some students of mine were about to test a piece that was an annulus—a pipe only. They drilled the hole out of solid iron, and after they broke it they brought it to me. I did not see anything peculiar about it, until they called my attention to the fact that at a certain place there had been no yield or no apparent stretch, and they said the drill broke when they got to about a third or less than one-half the length. To get out the broken piece they struck with a hammer on the side of the piece to jar it out. Now, where they struck with a hammer—not very heavy blows—all around the outside of the cylinder, it apparently did not yield at all. The stretch was outside of that. There was an object-lesson at once, which teaches us that every change that is made before or during a test affects the result. I am not surprised, for I have long known the fact that the rate of testing a piece —that is, the rate at which you break it, has an effect on the measured strength. It should; and so with regard to the composition, the manner in which it is manufactured, so in regard to the manner in which it is cut out, so in regard to the length of the piece, whether it has a shoulder or not. All these elements will affect the results, so that the only true method, it seems to me, of getting comparative results that are valuable, is to have them made under similar circumstances, and that the rate at which the piece is broken shall be an element in the test.

MR. MITCHELL: The worst strains we get are on the side rods of locomotives. There we use a very large factor of safety; it being about 12. We figure the centrifugal strain and that due to the piston, considering that the large factor of safety which we use covers all strains. We had one engine running about 40 miles an hour which broke both side rods. She slipped and we used sand, and she caught in the sand and another rod broke. I figured the factor of safety of those rods as nearly as I could, and I found it was only 4½. I built the rods much deeper, and we have not had any break since. I use a factor of safety of 12 with Otis steel.

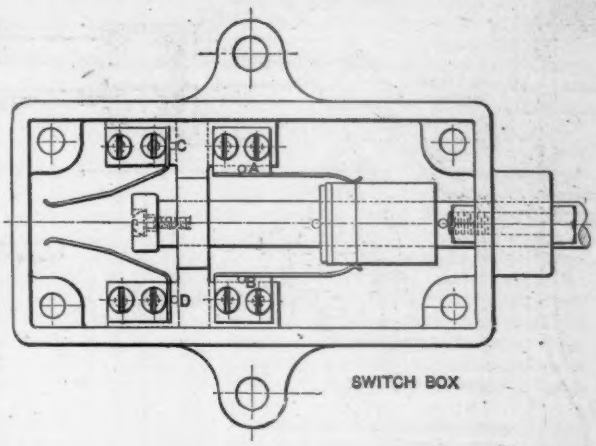
DR. EMERY: On that subject there is an interesting contribution in the transaction of the American Society of Civil Engineers. Mr. William Metcalf, himself a steel manufacturer, had occasion to make a machine in which two axles were to be connected, and he used two side rods like those of a locomotive, and run at much higher speed than a locomotive. Using steel that was soft, they broke very rapidly. It occurred to him that it would be a good thing to make them stiffer, and he put in some steel having .07 or .08 per cent. of carbon, and they would run so many years.

MR. MITCHELL: I claim that a rod, if properly designed, on an engine, using that factor of safety of 12, will last as long as an engine, and that is 25 or 20 years.

THE CHAIRMAN: I have here a letter from Mr. McFarland. It has been proposed to have the subject of the next meeting Marine Tubular Boilers, and Mr. McFarland, Past Assistant Engineer of the United States Navy, is expected to start the talk.

THE KINSMAN BLOCK SYSTEM.

THE Kinsman system of block signaling, as exploited by the Kinsman Block Signal Company, of 143 Liberty Street, New York, includes a cab signal with an automatic closing of the throttle-valve and application of the air brakes. It is an ingenious mechanism for avoiding the disastrous results which may arise from heedlessness on the part of the engineer or the invisibility of the signals beside the track. Besides being ingenious the system possesses the further merit of simplicity. Of course, electricity enters into the mechanism and occupies a prominent place in its operation. The fundamental idea of the device is that if a train is occupying a given block, or a switch is open therein, another train will be prevented from entering by the automatic closing of the throttle-valve on the engine and the application of the air-brakes.



SWITCH BOX

Before describing the cab mechanisms by which this result is obtained, we will look into the wiring and electrical devices that are used. Track circuits are employed. A primary battery has its two poles attached to the two rails, which are laid in insulated sections, each wire running to its rail direct as well as through a relay. When the track is clear this current passes uninterruptedly from the battery through the relay, and the armature of the latter is held against the magnets. Let a train enter the section, however, and straightway the wheels short circuit the current of this battery, the relay is cut out, and the armature drops upon its stops. In doing so it makes a connection by way of a local battery between two guard rails (contact rails they are called) insulated from each other and the main line, and placed at a suitable distance ahead of the protected section. In this condition no current is passing through the relay, and the circuit of the local battery is not completed. Should an engine pass these contact rails, the brushes with which it is equipped rub against them and complete the circuit of the local battery; this excites an electro magnet in the cab, raising its armature and causing the work already indicated to be done.

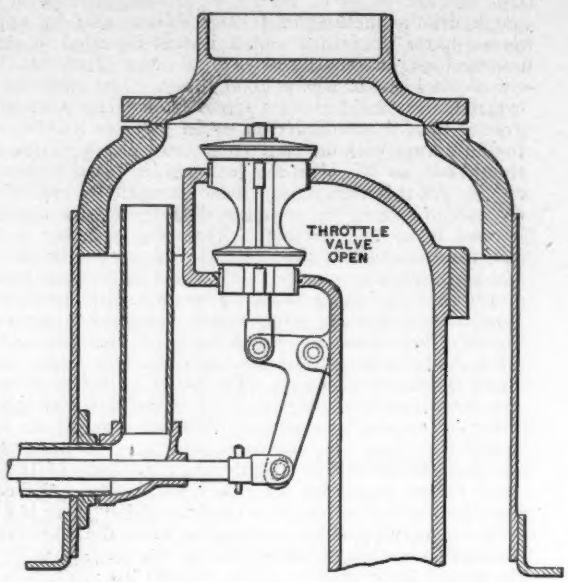
Switches are protected in a similar manner. Thus the two rails of a switch are connected to a relay set like the block section relay and operating in the same way. One wire passes through a contact point in a box attached to the switch-rod. This box is so constructed that when the switch is shut the current passes through the box and on to the relay; but when the contact is broken the current is not only interrupted, but, as a further precaution, it is short circuited by means of another contact point in order that every possibility of exciting the relay may be avoided. It will be seen by reference to our engraving that this box is of an exceedingly simple construction. It is rectangular, and contains a rod moving freely to and fro as the switch is operated. This rod has two hubs, each provided with a brass ring, one for making contact with the relay wire and the other for the short circuiting connections.

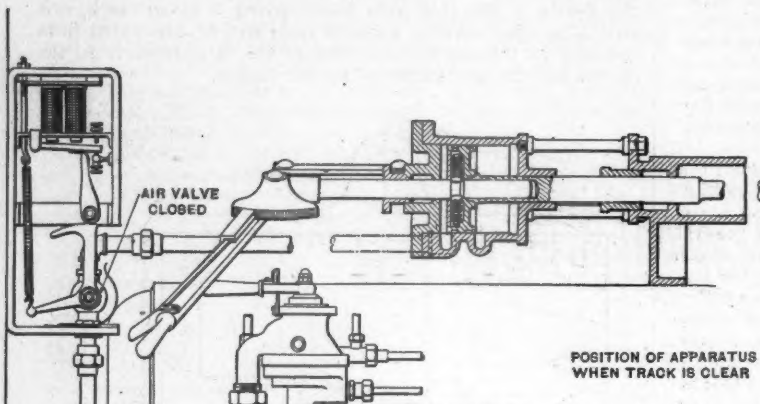
It will be seen, too, that should any accident happen to the main battery so that it becomes inoperative, the relay is demagnetized and the block closed.

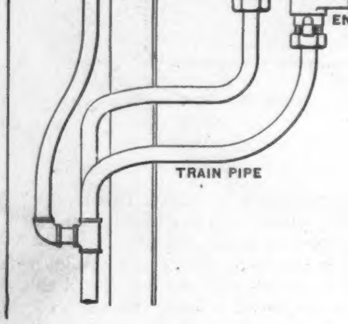
Coming now to the car mechanisms, our engravings show the apparatus in the free running and the automatically shut-off positions, the latter with the brakes set. There is no battery in the cab. The wires leading from the electro magnet shown run down to two contact brushes that are insulated from each other and fastened to the front truck. When these brushes strike the contact rails already described,

the circuit of the local battery is completed, provided that the armature of the corresponding relay has fallen and the following block occupied. When this occurs the armature of the cab magnet is raised, setting free a lever attached to a valve in the train pipe that is thrown open by a spring. This admits air, through the pipe shown, to a cylinder through which the throttle-rod works. This rod is in two pieces. The front end is hollow and is attached to a piston moving in the cylinder

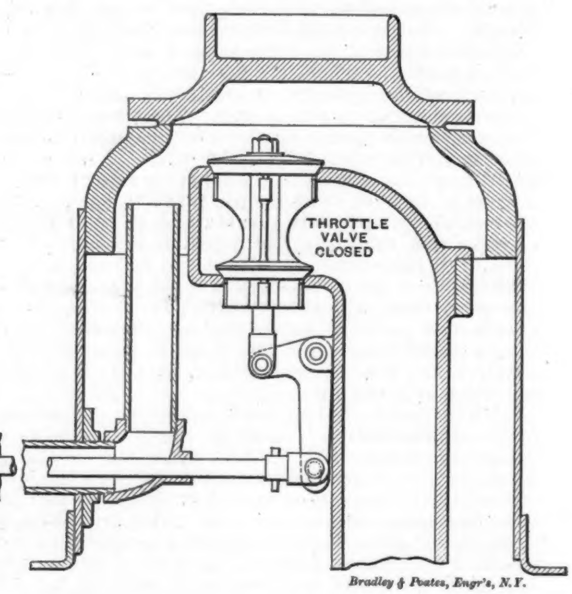
LOCOMOTIVE EQUIPMENT OF THE KINSMAN BLOCK SYSTEM CO.

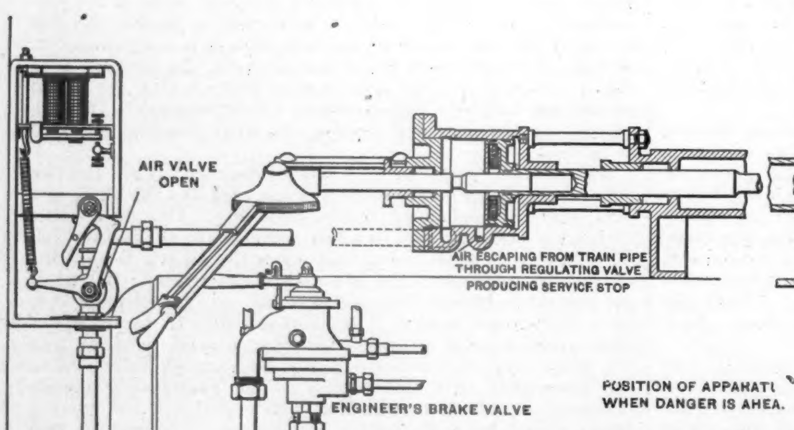


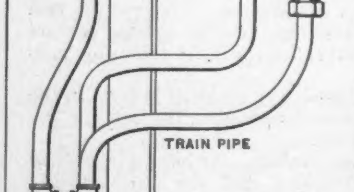




after the manner of the dogs of a chuck and pressed down into a groove in the solid rod by springs. This groove is bevelled on the front edge so that the dogs can rise over and the piston slip ahead when the throttle lever is locked should any excessive pressure be brought to bear against the piston head. The springs and dogs are, however, amply sufficient to maintain the connection with any hand manipulation of the lever.



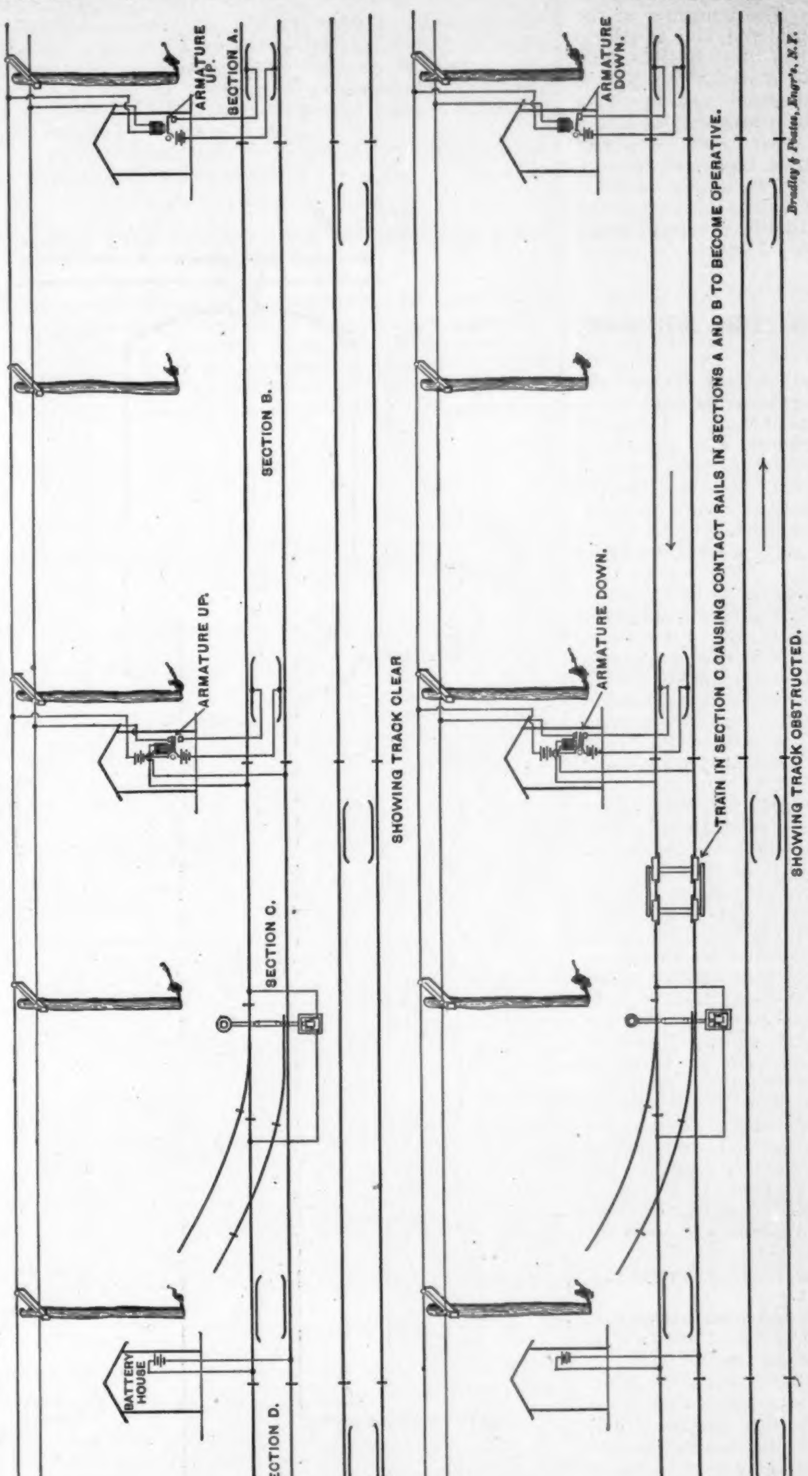




referred to above. The solid stem of the throttle-rod comes out of the back head of the cylinder and takes hold of the throttle lever in the ordinary way, no change of construction being made in the battery. The connection between the solid and hollow portions of the rod is made by means of four dogs set in the piston-head

Thus, when the armature trips the lever of the air-valve and the pressure from the train-pipe is admitted against the back of the piston, it is pushed ahead and the throttle is closed. When it has reached the end of its stroke and the throttle is closed, it uncovers the hole *E*, allowing the air from the train-pipe to escape and making an emergency application of the brakes. Thus there is no change in the cab mechanisms. The throttle lever remains in the wide open position and the handle of the engineer's valve is in the running position. The engineer recovers possession of this throttle-valve by merely pushing his lever ahead until the dogs engage in the notch, and his brakes are at once readjusted to the usual working condi-

tions by the raising of the air-valve lever until it again rests against the armature of the relay. The engine is then ready for another stop, nothing has been disarranged and nothing has been broken.



ARRANGEMENT OF CIRCUITS OF THE KINSMAN BLOCK SYSTEM CO.

STEAM LIFEBOATS.

THAT the efficient mechanical propulsion of a boat to be used for life-saving purposes has for a long time been a problem surrounded with apparently insuperable difficulties is evidenced by the fact that up to within the last three years but one of the few proposed solutions of it can be said to have met successfully the requirements of such a vessel. Propulsion by paddle-wheel was, as a matter of course, out of the question, and the application of the screw propeller had so many drawbacks in view of the conditions under which lifeboat service had to be performed, that the matter resolved itself into some efficient application of water pressure to give the requisite propulsive power.

In May, 1891, it was noticed in the *Times* that the Royal National Lifeboat Institution had in the previous September placed on trial at Harwich the first mechanically propelled boat intended for life-saving purposes. This vessel, named the *Duke of Northumberland*, was constructed by Messrs. R. & H. Green, the widely known shipbuilders of Blackwall, and engined by Messrs. Thorneycroft, of Chiswick. She is 50 ft. long, 12 ft. beam, and her loaded displacement at 3 ft. 6 in. in draft is 23 tons. Her propelling machinery consists of a horizontal compound surface-condensing engine of about 170 H.P., driving a nearly horizontal turbine of 30 in. in diameter, which delivers its water through two outlets in the sides of the boat, and draws its supply through a vertical scoop-shaped inlet amidships. The boiler is one of Mr. Thorneycroft's patent water-tube type, with a heating surface of 606 sq. ft., and grate surface of 8½ sq. ft. This boat, after going through an exhaustive series of trials, making during one of them the passage from Harwich to Holyhead, a distance of 1,000 miles, without the least mishap, was eventually placed on the station at Harwich, and has since done excellent service in the saving of many lives and much valuable property.

Owing to the success attained with this first attempt in the construction of a really serviceable mechanically propelled life-boat, Messrs. Green were instructed with orders to build two new boats for a similar purpose, one for the Royal National Lifeboat Institution, and the other for the Lifeboat Institution of South Holland. These vessels have the following principal dimensions: Length, 53 ft.; beam, 16 ft.; depth, 5½ ft.; and their loaded displacement is 30 tons, giving them a draft of 3 ft. 3 in., at which they will carry from 30 to 40 passengers, four tons of coal in the bunkers, and half a ton of fresh water in their reserve tanks.

The experience gained at and since the trials of their first vessel of the type has enabled her builders to make material improvements in the two now nearing completion. The first of them—or that intended for the Royal National Lifeboat Institution—launched some months ago, is nearly ready for her official trial; the second—that for the kindred institution in South Holland—was launched recently, and named by Miss Ella Green, daughter of one of the partners of the firm of builders, the *President Van Heel*. As these vessels are sister boats, the improvements effected in construction and machinery apply to both.

Instead of propulsion being dependent, as in the case of the *Duke of Northumberland*, upon one turbine and inlet to feed it, the new vessel is fitted with two vertical centrifugal pumps placed on the starboard and port sides, driven direct from the crank-shaft—to which they are coupled and co-axial—of an inclined compound direct-action engine of 200 H.P. For forward and backward motion, go-ahead and go-astern, outlets—the former in the bottom and the latter in the sides of the vessel—are connected by pipes to each of the pumps, and to give a lateral propulsion to the boat a special side outlet has been arranged—which has been patented by Mr. J. F. Green both in England and abroad—the advantage of which when

manœuvring round a wreck is considered invaluable, as the water can be discharged through the outlet nearest the wreck and thus act as a buffer or fender in keeping the boat and the wreck from colliding, and assisting it by sideways propulsion in getting clear away when desirable. The buoyancy of the new vessel has been very carefully considered, and to add to her safety she is divided into no less than 13 water-tight compartments; but should one of these be stove in, provision is made to connect it with the centrifugal pump inlets in such a way that the inflow of water would be utilized for the boat's propulsion. The boiler for supplying steam to the compound engine of the vessel is of the water-tube type, and will, together with the whole of the propelling machinery, be fitted by Messrs. John Penn & Sons, of Greenwich. It is expected that the official trial of the first of the improved type of steam lifeboats will shortly take place.—*London Times.*

THE ADAMS UPRIGHT WATER-TUBE BOILERS.

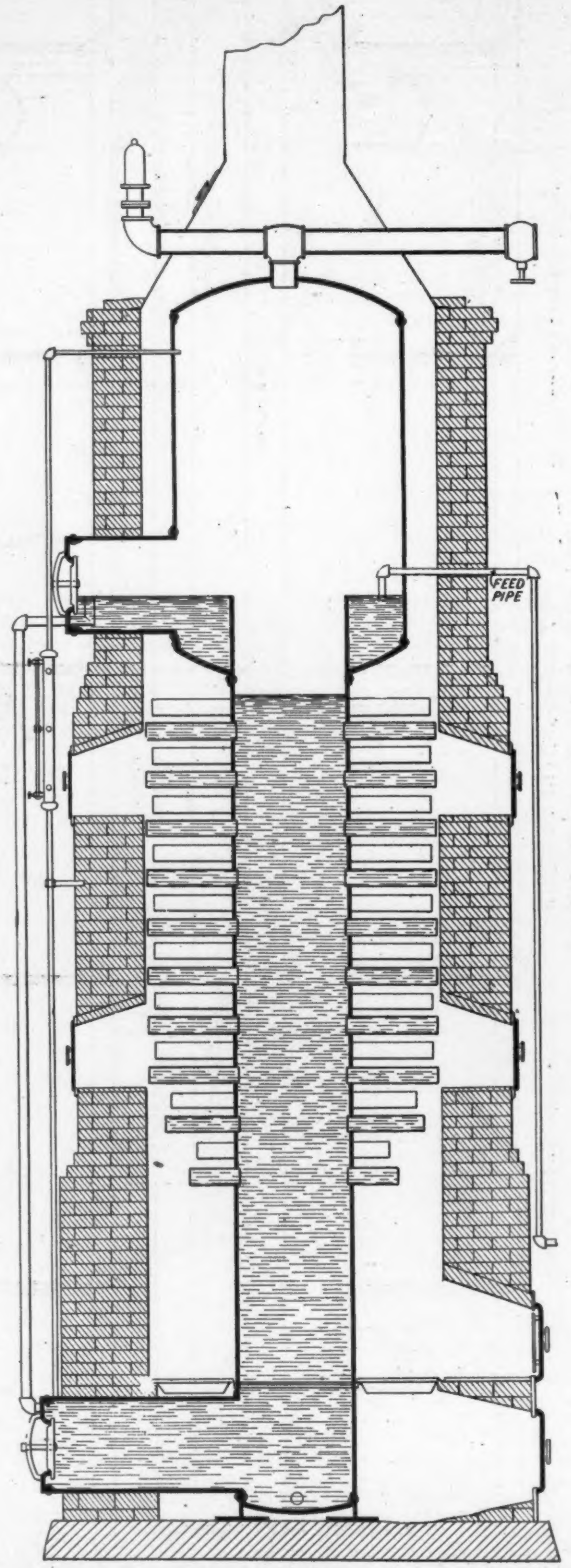
We illustrate a boiler made by the Adams Water-Tube Boiler Company, of Cleveland, O., that presents some novel features in the construction of this class of boiler. The great difficulty that has heretofore been experienced with water-tube boilers that might be called of the porcupine type has been that the amount of sediment and scale deposited in the tubes has been so extensive as to cause them to burn out very rapidly, as well as the fact that the arrangement of the tubes and the conditions under which they were worked rendered circulation almost impossible.

The boiler under consideration is so designed that it is evident that there must be a continuous circulation, and at the same time the sediment held in solution by the water is deposited in such portions of the boiler as to be readily cleaned, and not in localities where it will burn to the surface. The vertical section shows that the boiler consists of a vertical column filled nearly to the top with water, from which tubes radiate into the fire spaces. The lower portion of the boiler has a mud drum, which is below the grates and is not affected in any way by the intense heating of the fire.

At the top of the boiler, and just beneath the steam space, there is a basin into which the feed-water is projected. This basin is kept nearly filled, and the water in it is heated to the temperature of the steam; but inasmuch as it is only subjected to the heat of the gases in the upper portions of the flue, comparatively little steam is generated at this point. The vertical column is kept filled to a point above the top of the highest of the lateral tubes, so that all of these are constantly full of water. A circulating pipe starts from one side of the basin at the top and passes down into the mud drum beneath the grates. In this way there is a constant supply of water flowing from the top down to the bottom, which supplies the water evaporated. The circulation, therefore, is upward; and the water which has been heated in the basin under the steam dome deposits therein a portion of its sediment, and the remainder falls to the bottom of the mud drum beneath the boiler, from which it is readily removed by man holes located as shown on the drawing. The man-hole in the steam dome also enables the basin to be emptied and cleaned. It is claimed that the constant upward tendency of the steam which is generated from water that is practically pure causes no sediment to be deposited in the tubes.

The steam-dome is made of ample size to allow for the sudden withdrawal of steam by the engines.

At a test made at the Falcon Tin Plate and Sheet Company's works, at Niles, O., in February last, 9.74 lbs. of water were evaporated per pound of fuel from a temperature of 212°. A memorandum of the fuel used showed that it was a low grade of bituminous coal. The test covered three upright boilers of 225 H.P. each. These boilers had a heating surface of 9.38 sq. ft. per H.P. The test was so successful that a 500 H.P. boiler for the company, at whose works these were tested, is now being built.



THE ADAMS UPRIGHT WATER-TUBE BOILER.

TANK ENGINE.

Designed by Charles Brown of Basle, Switzerland.

Some of our readers will remember the neat, ingenious and elegant designs of locomotives brought out by Mr. Charles Brown when he was Superintendent of the Locomotive Works at Winterthur. He is now located at Basle, and has sent us a photograph from which the engraving herewith was made, and from which it will be seen that he has "lost none of his cunning."

This engine is intended for small lines laid on common roads, of which many hundreds have been made. "It is peculiarly adapted for this class of work," Mr. Brown writes us, "for the following reasons":

"1. The slide-valves are *underneath* the cylinders, and thus give self-acting drainage; no drain-cocks are required, no frightening of horses. This arrangement saves one-sixth of the fuel used by engines with slide-valves *above cylinders.*

"2 The working gear, connecting and coupling-rods, are all in the same plane.

"3. The bearings and springs are *outside* the wheels, and the *tanks inside*, which gives steady running on narrow gauges on uneven roads.

"4. Slide-valves are of the Church pattern, which are self-adjusting for wear, . . . never require readjusting. This is of importance in countries where no shops are at hand.

"5. All lubrication is by means of grease absolutely closed against intrusion of grit, saving of 90 per cent. of material, and vastly reduced amount of wear.

"6. All valves which have to be *ground* in from time to time are get-atable from the outside."

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in March, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN MARCH.

Nuzum Mills, W. Va., March 1.—A freight engine on the Baltimore & Ohio Railroad exploded its boiler at this point today. Engineer Stevenson and Fireman Law were terribly injured.

Silican, Mo., March 1.—A freight train on the Mississippi River & Bonneterre Railroad went through a bridge a mile south of Herculaneum this afternoon. The engineer, George Jump, was instantly killed. The fireman was seriously injured.

Brooklyn, N. Y., March 1.—A collision occurred on the Brooklyn Elevated Railroad at Broadway and Manhattan crossing, in which an engineer and fireman were badly hurt.

Winnimac, Ind , March 4.—A freight train on the Panhandle Line ran into the rear end of another train at this point this morning. Engineer Ide received injuries from which he will probably die. Fireman Merrill was thrown from the cab and badly scalded about the body. The engineer is said to have been asleep at the time.

Columbus, O., March 6.—A sleeper at the rear end of a train on the Pennsylvania Railroad jumped the track near this point this morning, and ran into a switch engine standing beside the main line. Fireman John McCormick was badly hurt.

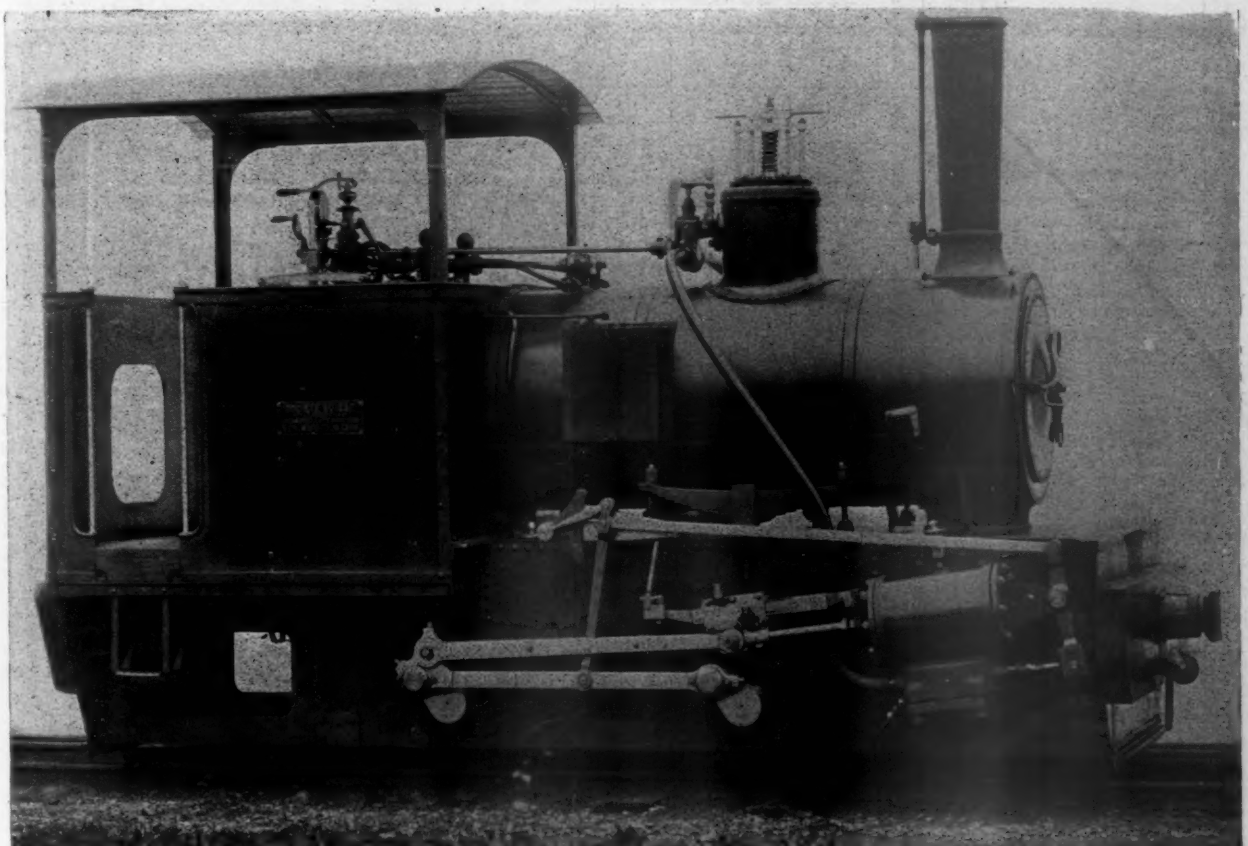
Gainesville, Tex., March 6.—An unsuccessful attempt was made to rob a passenger train on the Gulf, Colorado & Santa Fé Railroad early this morning. Two piles of ties were placed upon the track. The engineer and fireman saw the obstruction in time to jump, and escaped with a few bruises.

Pittsburgh, Pa., March 7.—An engine with five coal cars on the Pittsburgh, Youngstown & Ashtabula Division of the Pittsburgh & Fort Wayne Road, was swept off the track by a landslide this morning. None of the trainmen were killed, but Engineer M. Hubbard and Fireman George Jones were seriously injured.

Roanoke, Va., March 8.—A vestibule train on the Norfolk & Western Railroad, between Washington and Chattanooga, ran into a landslide 45 miles north of this city this morning. Engineer Jake Hardy was killed. Fireman Kroftsinger was thrown down the embankment of the James River and severely injured.

Wilkesbarre, Pa., March 8.—A locomotive on the Lehigh Valley Railroad exploded its boiler at White Haven to day. The fireman, John Lenox, was killed. The engineer was in the telegraph office for orders.

Oil City, Pa., March 9.—A freight train on the Western New York & Pennsylvania Railroad ran into a landslide 7 miles east of here this morning, causing the death of Fireman Martin.



TANK ENGINE, DESIGNED BY CHARLES BROWN, OF BASLE, SWITZERLAND.

LOCOMOTIVE RETURNS FOR THE MONTH OF JANUARY, 1894.

Name of Road.*	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Canadian Pacific	602	....	492,375	649,273	295,610	1,437,358	2,387	....	....	....	....	....	81.13	....	....	4.09	12.59	0.38	....	5.73	1.52	24.31	....	....	3.10
Chic., Burlington & Quincy	542	....	....	....	....	1,449,971	2,675	4.72	17.78	....	....	....	89 96	....	....	4.55	6.39	0.23	0.33	7.26	0.06	18.82	....	....	1.41
Chic., Milwaukee & St. Paul	855	....	....	....	....	2,251,165	2,633	....	....	....	....	....	77.39	....	....	4.25	7.91	0.29	....	6.95	....	19.40	....	....	2.43
Chic., Rock Island & Pacific	564	....	477,450	789,820	375,722	1,642,992	2,913	....	....	62.91	8..24	48.25	71.02	....	....	3.33	7.05	0.26	....	6.28	0.43	17.35	....	....	2.14
Chicago & Northwestern	1010	....	810,744	1,282,623	564,515	2,657,882	2,631	....	....	....	....	....	93.72	....	....	4.12	8.51	0.31	....	6.33	0.92	20.19	....	....	1.80
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	23	23	5 858	25,148	....	31,006	1,348	....	....	....	....	....	88.18	....	....	9.97	4.48	0.35	....	....	2.39	17.19	....	....	....
Delaware, Lackawanna & W. Main L.	211	180	71,385	201,355	292,081	564,821	3,138	....	....	....	....	....	91.66	....	....	3.07	7.18	0.41	....	5.92	....	16.58	....	....	1.55
Morris & Essex Division	162	....	182,648	146,383	84,805	413,836	2,554	....	....	....	....	....	68.59	....	....	3.10	10.68	0.30	....	6.40	....	20.48	....	....	3.09
Hannibal & St. Joseph	67	67	....	....	....	252,916	3,775	4.77	15.98	....	....	....	87.32	14.65	7.37	2.37	6.00	0.11	0.41	6.69	0.03	15.61	....	....	1.44
Kansas City, F. S. & Memphis	146	....	94,085	223,489	93,699	411,273	2,817	....	....	....	....	....	70.89	....	....	2.93	5.59	0.24	0.48	7.38	....	16.62	....	....	1.55
Kan. City, Mem. & Birm	41	38	36,214	62,623	14,131	112,968	2,972	....	....	....	....	....	67.61	....	....	2.71	3.79	0.30	0.29	6.97	....	14.06	....	....	1.08
Kan. City, St. Jo. & Council Bluffs	36	36	....	....	....	131,988	3,771	4.71	18.04	....	....	....	70.69	16.70	4.94	3.69	6.87	0.16	0.33	6.28	0.04	17.37	....	....	1.99
Lake Shore & Mich. Southern	593	....	423,400	824,850	412,571	1,660,821	2,800	....	....	66.11	94.21	41.71	67.34	....	....	2.72	5.65	0.12	0.06	6.85	0.19	15.59	....	....	1.54
Louisville & Nashville	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	304	777,302	....	68,644	845,946	2,782	....	....	....	....	....	45.58	....	....	3.00	8.80	0.20	....	9.00	....	21.00	....	....	4.02
Mexican Central	148	123	....	....	....	438,463	3,584	....	....	....	....	....	67.12	....	....	6.17	13.56	0.35	0.09	4.97	....	25.14	....	....	4.46
Minn., St. Paul & Sault Ste. Marie	103	90	84,885	147,570	37,285	269,740	....	4.67	18.19	....	....	....	83.71	....	....	4.57	14.71	0.28	....	6.48	....	26.04	4.99	1.64	3.50
Missouri Pacific	351	....	....	....	....	945,697	3,289	4.40	15.42	....	....	....	92.46	....	....	4.98	6.42	0.33	1.48	6.28	1.49	20.95	3.92	1.69	1.36
Mobile & Ohio	107	87	75,262	151,814	58,947	286,023	3,288	....	....	....	....	....	69.71	....	....	2.59	5.00	0.22	0.61	5.32	0.91	14.65	....	....	1.43
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	632	415	438,128	753,379	250,240	1,441,747	3,474	4.30	22.40	96.40	146.90	94.45	179.25	22.30	6.60	5.79	8.49	0.39	2.20	7.41	1.33	25.61	....	....	1.43
N. Y., N. H. & H., Old Colony Div	....	....	363,674	143,440	169,824	676,938	....	3.80	14.90	....	....	....	68.18	19.00	6.30	3.44	10.24	0.69	....	7.22	0.94	22.53	....	....	....
N. Y., Pennsylvania & Ohio	275	184	125,217	398,896	116,635	640.748	3,482	5.20	16.40	82.20	129.20	105.35	105.58	....	....	4.83	5.86	0.32	2.57	6.86	1.12	21.56	....	....	1.05
Norfolk & Western, Gen. East. Div.†	....	....	93,427	267,168	49,305	409,900	2,562	4.96	20.26	53.97	131.74	....	92.85	10.87	6.50	4.95	3.98	0.28	....	....	....	9.21	....	....	....
General Western Division†	....	....	99,403	301,222	47,386	448,011	2,605	5.61	15.91	83.00	142.00	....	132.00	13.62	8.89	7.34	4.49	0.27	....	....	....	12.10	....	....	....
Ohio and Mississippi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	427,086	287,068	733,578	1,447,732	....	....	....	....	....	....	80.80	....	....	4.95	4.94	0.34	....	5.79	0.48	16.50	....	....	....
Southern Pacific, Pacific System	736	630	637,165	654,553	256,593	1,548,311	2,458	5.31	13.48	....	....	....	66.62	....	....	5.11	15.86	0.19	2.19	7.29	1.27	32.51	....	....	4.78
Union Pacific	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6.13	0.92	15.57	....	....	....
Wabash	425	350	432,112	630,141	223,369	1,285 622	3,673	4.48	16.44	71.47	112.42	58.91	89.85	15.93	6.25	3.12	5.12	0.28	....	....	....	....	2.97	1.09	1.17
Wisconsin Central	149	103	115,263	169,651	48,746	333,660	3,239	....	....	....	....	....	87.07	....	....	2.30	9.80	0.17	....	7.17	....	19.44	....	....	....

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

San Antonio, Tex., March 10.—Joe Miller, locomotive engineer on the Mexican International Railway, was killed by an engine turning over on him.

Montpelier, Vt., March 11.—An express train on the Vermont Central Railroad ran into two large boulders about three miles north of here this morning. Engineer McKenna was killed, and the fireman had his shoulder dislocated.

Capelton, Quebec, March 12.—A head-end collision occurred on the Boston & Maine Railroad near here to-night between an express train and a local. Engineer McDuffee and Fireman McPherson were instantly killed.

Pittsburgh, Pa., March 15.—A long freight train drawn by two engines ran into a landslide near Sample Station to-night. Engineer Ross and Develin were thrown from their cabs on to the mass of rocks and earth and received painful injuries.

Portland, Me., March 19.—A work-train on the Maine Central Railroad struck a section hand-car between Newport and East Newport this morning. The locomotive was thrown from the track, and the engineer, Frederick D. Wing, was killed.

Fort Worth, Tex., March 20.—The engine of a freight train on the Texas Pacific Railroad struck a horse near Santo to-day and ran into the ditch. Engineer W. F. Cross was fatally, and Fireman Youngblood seriously, injured.

Sylvan Station, Pa., March 23.—A passenger train was derailed by an open switch at this point to-day. The engine plunged over an embankment and the fireman was killed.

Amsterdam, N. Y., March 31.—A west-bound train on the New York Central Railroad, consisting of express cars, ran into a freight train at this point this morning. The engine ran down an embankment, and Engineer Wilkinson was injured.

Our report for March, it will be seen, includes 18 accidents, in which 8 engineers and 4 firemen were killed, and 6 engineers and 11 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Broken-down bridge	1
Cattle on track	1
Collisions	4
Derailments	1
Landslide	5
Misplaced switch	1
Overturning of engine	1
Ran into hand-car	1
Train wrecking	1
	18

PROCEEDINGS OF SOCIETIES.

Meeting of Members of the Mechanical Engineers.—The next meeting of the Mechanical Engineers for the discussion of technical subjects will be held in the hall of the Society on Wednesday evening, May 9, at eight o'clock. The subject for discussion will be The Use of Water-tube Boilers in the U. S. Navy. An introductory "talk" or paper will be read by W. M. McFarland, Passed Assistant Engineer U. S. N. This will be the last of the series of meetings which have been held during the past winter.

Engineering Association of the South.—At the regular March meeting a paper was read on the Coal Handling Plant at Pikeville, Tenn. Owing to increasing competition among coal mines and consequent demand for better product, old, simple forms of chutes are now being superseded by those in which the coal is thoroughly cleaned and tenderly handled. The mine cars are carried to and from tipple by self-acting creeper chain. Coal is dumped on back tippler, eliminating large amount of breakage of coal usual in old-style tippler. Lump is made over shaking screens, 1½ in. perforations, inclination 1½ in 12. Coal is lowered gently into cars by specially designed chute, having had nowhere a direct drop of more than a few inches. Nut and slack are elevated together and separated on shaking screens, ½ in. perforations, inclination 3½ in 12. Good results are obtained from corrugating these screens. The uniformly sized slack made by this plant greatly improves physical properties of coke. The use of perforated metal shaking screens, compared with that of bar screens, increases both quantity and quality of salable coal. Capacity, 1,000 tons per day; cost, $4,400; estimated running expenses, $6 per day. The plant was designed and erected by Mr. J. J. Ormsbee, Superintendent, Sequatchie Valley Coal & Coke Company.

PERSONALS.

Mr. George O. Manchester, formerly of the Atchison, Topeka & Santa Fé Railroad Company, has been elected Vice-President and Treasurer of the Sargent Company, Chicago.

C. M. Mendenhall has been appointed Assistant Engineer of Motive Power of the united railroads of the New Jersey Division of the Pennsylvania Railroad Company, to take the place of Samuel Porcher, who has been promoted.

Mr. B. J. Williams, who has been Secretary and Treasurer of the Shelby Steel Tool Company, up to the present time, recently tendered his resignation, for the reason that the banking business with which he has long been associated demanded more of his time than he could devote and attend business with the Shelby Company. Mr. J. C. Patterson was elected his successor. The business of the company has been one of continued prosperity, the last month showing the shipment of nearly 3,350 ft.

OBITUARY.

Edward Barry Wall.

When those who are old and feeble, or others, from whom the hope and cheerfulness and buoyancy of life have been sapped by misfortune or illness, are taken away, death even then, if they are our friends or are still nearer to us, always comes as a surprise. But when one in the prime of life, and standing on the threshold of distinction, with a past career full of promise of future usefulness, and of a nature which charmed all who came under its influence, is taken, the announcement comes like a relentless blow to which we must submit reverently and resignedly, if we can. The sad news of the death of Edward Barry Wall came in this way to many of his friends and acquaintances, who had no previous intimation of his illness. He died in the Homœopathic Hospital, in Pittsburgh, on the evening of Sunday, April 1, after an operation for appendicitis. The immediate cause of his death was the shock from the operation, but his disease was complicated with peritonitis.

He was born in Kingsborough, N. Y., on April 25, 1856, and was the son of Professor Edward Wall, who occupies the Chair of Belles Lettres in Stevens Institute in Hoboken, and Sarah Berry Wall. His early education was received at the Brooklyn Polytechnic Institute and the Martha Institute in Hoboken. In 1872 he entered the Stevens Institute at Hoboken, and graduated in 1876. It was during this period that the writer first made his acquaintance. From the dates given above it will be seen that he was only 16 when he entered Stevens Institute. He was then short of stature for his age—and was extremely boyish-looking even for a youth of his years, but with a mind even more active than his body—and that seemed to be so overflowing with vitality as to be almost out of his control. He was then a frequent visitor to the office of the *Railroad Gazette* in search of information relating to his studies at the Institute. It was sometimes almost comical to hear from a mere boy, who did not appear to be more than 12 or 14 years old, inquiries for information about matters which the editors of that paper would have been only too glad to have received satisfactory answers from any source whatsoever. Any intelligent person who came in contact with him then could not help seeing that this seeming youth had in him the potentiality of a distinguished man. His jovial good-nature—such a marked characteristic of his later life—then fairly bubbled over, but was always under restraint and made subservient to his more serious duties. Notwithstanding his overflowing animal spirits, his nimble and inimitable wit, the elastic buoyancy of his nature, he never failed to treat those older than himself with that consideration which was, perhaps, their due. In later years, when the acquaintance of those early days ripened into a closer and more intimate friendship, the writer recalled, with a curious feeling of grotesqueness, the respectful deference with which he was treated by this youthful student, who later became such a charming companion and friend.

Before finishing his studies he was engaged for a short

time in making a series of experiments in boiler explosions, which were carried on at Sandy Hook. These experiments were made to throw some light on the cause of boiler explosions, which theretofore had been attributed to all sorts of causes excepting the true one—that of insufficient strength in the boiler to resist the steam pressure to which it was subjected. A destructive explosion was produced during these experiments simply by an over-pressure of steam.

On graduating at the Stevens Institute he was made salutatorian of his class, and soon after went to Altoona as an apprentice in the car shop, and worked there for about two years. He was afterward employed in the testing department of the Pennsylvania Railroad at Altoona.

In 1883 he was appointed Assistant to the Master Mechanic of the Pittsburgh, Cincinnati & St. Louis Railroad, at Columbus, O. In 1883 he was made Superintendent of Motive Power of that line, and was then noted for being the youngest man occupying such a responsible position in the country. About this time he became a member of the Master Car-Builders', the Master Mechanics' Associations, and the American Society of Mechanical Engineers. He was also one of the trustees of the Stevens Institute.

On June 24, 1892, he was married to Fanny Mitchell, daughter of General John G. Mitchell, of Columbus, O. A deep shadow was cast over his life by the death of his wife in childbirth, on August 12, 1893. A son named after his father survives them both.

At the opening of the World's Fair in Chicago the father was appointed Assistant to the Vice-President of the Pennsylvania Lines West of Pittsburgh, with his office in Chicago. During the Exhibition he was very much interested in it, and was one of the judges of awards in the Transportation Department. After the Exhibition closed he was appointed Assistant to the General Manager of those lines, with his office at Pittsburgh. His duties in this position were somewhat peculiar. The object in creating the office was to give some one, with technical knowledge and practical experience, control over the purchases of the road, so that not only would the prices which are paid receive proper consideration, but the value of the materials bought would also be submitted to the critical judgment of a competent person. He occupied this position at the time of his death. He was also a member of the Duquesne Club, of Pittsburgh, and had been a member of both the Chicago and the Columbus Clubs in those two places.

Very truly yrs —
Edwd B. Wall

It is not easy, in a brief memoir like this, to do justice to his abilities and character. His striking trait was an exuberance of animal and mental spirits, with a constant effervescence of wit and humor, which was the perpetual delight of those who were not too dull to enter into the spirit of it. It should not be inferred from this that he was overmuch given to levity. It is true that he sometimes sorely perplexed his duller brethren, who had not the mental agility to follow him in the leaps and bounds of his pleasantry, over very ordinary and sometimes extraordinary matters. There was a deep seriousness in his character over which this jocose fancy was only a thin veil, but which nevertheless some never saw through. Although at the head of the mechanical department of a great railroad, it cannot be said of him that the bent of his mind led him in the direction of being a mechanical genius. It is doubtful whether he had any great love for mechanical matters. His aptitude and endowments seemed to incline him more in the direction of executive duties, to the control and management of affairs and men rather than to mechanical construction and design. But if we assign to the calling of an engineer the celebrated definition, that it is "the art of directing the great sources of power in nature for the use and convenience of man," then the subject of this memoir may rank high in that occupation. The shops of the Pittsburgh, Cincinnati & St. Louis Railroad, over which he had supervision, were noted among railroad men for being among if not *the* best ordered in the country. Those at Columbus and Indianapolis especially always excited the admiration of master mechanics and others competent to form opinions in such matters. In all subjects pertaining to mechanical engineering he had a very quick apprehension, sound judgment, and ever ready administrative ability—traits more valuable to his employers, probably, than mechanical genius would have been.

He was for a long time one of the most active members of the Master Car-Builders' Association, and for a number of years was one of its Executive Members and served on the Board of Directors. In that capacity his incisive good sense helped the Board out of many a tangle and difficulty. He never could be enticed from the real marrow of any question by a phrase or a prejudice. He seemed to have the faculty of not only seeing questions, but of weighing them, and his mind had the capacity—which is comparatively rare—of apprehending the *mass* of a question as well as its *surface*.

In the proceedings of the Association itself he was always very active, and served nearly every year on one or more committees of investigation, the reports of which he often wrote himself, or assisted in writing them by his advice and suggestions, and these were always of much value to his co-laborers and to the Association.

To him should belong the credit of introducing and securing the adoption of a resolution, by the Association, approving of the type of automatic car-coupler which is now the standard in this country. A retrospect of this action will be doing nothing more than justice to the subject of this memoir.

In 1883 a committee was appointed by the Car-Builders' Association to make a report at the next meeting, to be held in 1884, on Automatic Freight-Car Couplers, the purpose in appointing the committee and having the report made being the hope that it would lead to the adoption of some standard form of automatic coupler. At the meeting held in Saratoga, in 1884, the committee submitted a report, in which they referred to eight different couplers as "worthy of special mention," 12 more "as meritorious," and 13 more which "the committee have also examined;" and the report wound up with the negations "that the subject is one which should not be passed over lightly," and that "thorough investigation and prompt action is demanded," and recommending that a committee of experts to do various things—which would have been useless if they had been done—be appointed. The report was merely fatuous, but the purlieus of the convention were filled with the representatives of the various couplers, which were referred to in the report, and these men were goading on members to take some action. An excited discussion followed, which promised to be fruitless and purposeless. The members always spoke of their associate simply as "Wall," who then took part in the discussion by saying:

"I think that it is almost imperative that we should adopt something, or else own up that we cannot. There are a certain number of confusing questions that surround the matter of couplers. I think that we can here, this afternoon, decide on a certain number of principles which any coupler should fulfill. If we decide on these principles, then they will be known as the opinion of the Association, and inventors who will take the question up can see what conditions they must fulfill when they invent a coupler; and those who have invented couplers which do not fulfill these conditions will see that there is very little opportunity to present their coupler before this Association.

"If any one were going to hire a man to roll wheels, and somebody were to ask us to make specifications of that man, we could do so; we would say that the man must be healthy, strong, agile, quick. We can also say the same thing about a coupling. In order to bring this matter to an issue before this meeting, I would like to submit a motion.

"*That it is the sense of this Convention that any automatic coupling presented here should couple in a vertical plane;* by that, I mean should be able to slide up and down."

Later, in explanation of this motion, he added.

"The great advantage of a vertical coupler is that, notwithstanding the inequalities of the track, the different height of cars, you can couple with any kind of cars with a coupler that couples in a vertical plane."

Mr. Cloud afterward added: "I will move to amend the motion as it was put, and to introduce the word 'mechanically.' That is to say, that it is the sense of this Convention that the best coupler 'mechanically' is one which performs the coupling along a vertical plane."

This amendment was accepted, and in that form the resolution was adopted. Afterward Wall added—and with the light of more than a decade on this question his words seem prophetic—"I submit, Mr. President, that in passing the motion which has just been carried, we have done away with the link-and-pin coupling or any coupling which involves that principle. We have voted that it is the sense of the meeting that the coupler which best fulfills mechanical principles shall couple in a vertical plane; *that necessarily does away with links and pins.*"

The opponents of the measure did not realize at first that they were totally routed, and they tried to retrieve their lost ground, until finally the following resolution was ironically proposed, and was actually adopted, by the votes of those who opposed the original resolution:

"*Resolved,* That the Convention recommends to any railroads wishing to experiment with couplers not belonging to the most mechanically perfect class, as Janney's or Cowell's, to experiment with the following: The Archer, Ames, United States, Mitchell, Wilson & Walker, Conway Ball and Gifford."

It was never learned that any railroads "wished to experiment with couplers *not belonging* to the most mechanically perfect class."

By his courage and adroitness and the quick invention of the happy descriptive term, "*vertical-plane coupler,*" the measure was carried through triumphantly, and has been and will continue to be the direct means of saving hundreds or thousands of lives, and preventing an untold amount of suffering and pain.

He always took a very active part in the business of this Association. Among the older members of this body was one, a man of long experience in his occupation, and with convictions which he was always ready to advocate. He was one of the few representatives left of the old-fashioned New England mechanic, with a strong down-East dialect, conservative in his views, but keen, shrewd and loquacious. He and Wall were the very opposites of each other in both body and mind—the one was tall and thin and resembled the typical presentment of Brother Jonathan, with a sharp, shrewd face, and with a mind which moved slowly, but with considerable momentum; the other was short and stout, with a face beaming with smiles and hilarity, and whose mind and speech were always quick, agile and incisive. What may be called the contestations of these two men afforded an infinite amount of entertainment and often much instruction to their fellow-members. Our New England friend would rise and state his proposition and opinions, always at considerable length, and deliver them like a broadside from an old-fashioned man-of-war. Wall would then hover around him somewhat like a modern torpedo boat about an ironclad, and at the first opportunity would deliver a shot, which went as direct to the vulnerable point of his opponent's facts or arguments as a shell from a rifled gun, and was often quite as destructive as such a missile would have been to a wall of wood. After such encounters they would both drum their forces to quarters with the utmost good humor on both sides, and, to speak colloquially, would again "lay for each other."

Of the many delightful incidents which have been current among Wall's friends, was one which occurred at a political meeting to which he was appointed a delegate. It should be mentioned, perhaps, that he took a deep—and it hardly need be added—an *intelligent* interest in public affairs, and had a leaning which inclined him in the direction of political life. Like many other good people, he could not brook the nomination of Blaine for the Presidency, and went as a delegate to a protesting meeting in Chicago. While there there was the usual amount of boisterous and more or less senseless oratory and enthusiasm characteristic of such meetings, and at the mention of the name of Lincoln three cheers were proposed, and when Garfield was mentioned there were more cheers, and at the mention of the names of other men and measures there was vociferous applause, etc. And now the speaker said, "These people have not seen the handwriting on the wall. [*Cheers.*] In the nomination of James G. Blaine [*again there were cheers*] they have invited us to a Belshazzar feast." "Three cheers for Belshazzar!" shouted Wall, and they were given until the roof rang, and before the crowd learned that they were cheering an ancient reprobate who had been dead some thousands of years and who probably has not been cheered since then.

In a letter to his brother, written only a few weeks before his death, Wall congratulated him in this brotherly way, so characteristic of his nature: "I was glad to learn that you came through your counsellor exam's with flying colors. There was nothing else for you to do, and we all had that cruel confidence in you which a fellow has no escape from."

Again, what could be more charming than this tender reference to his motherless boy, in the same letter in which he congratulated his brother:

"Barry," he said, "was charming at Columbus on Tuesday evening, fat, fresh and bright—no crying or muling either in his heart or at his little mouth—which, by the way, is very small in repose, but goes from ear to ear, like his uncle's, when he grins."

In writing a brief account like this, which can do such scant justice to the friend and companion of many who will read it, the sad shadows which are cast by the still fresh recollections of his charming nature lead naturally to a record of those traits which were most attractive to us who knew him, to his joyous life, his good-fellowship, his *Gemüthlichkeit*—as the Germans express it; and yet, if this side of his character were alone portrayed, it would not do full justice to those stronger traits which were revealed whenever there was occasion for their exercise. There was probably no young man engaged in what, for the want of a better term, must be called "railroading," of whose future so many flattering predictions have been made. His associates instinctively felt that there was a brilliant future before him. His talents, as has already been remarked, led him in the direction of executive duties rather than to those of the reflective mechanic, inventor, or engi-

neer. In the administration of affairs he had already won distinction, and those who knew him best felt that, perhaps, the only bar in the way of a more rapid promotion, a few more years of age and experience would remove. His life may be likened to a fertile field, which had been carefully cultivated and sown. The waving grain was full of promise, but, in this world, the full harvest will never be gathered.

The following notice of the death and recognition of the worth of the friend and companion of so many of our readers has been published, since the above was written, in the annual report of the President of the Pittsburgh, Cincinnati, Chicago & St. Louis Railway Company:

"While engaged in the preparation of this report, death has again deprived the company of the services of one of its most promising and valuable officers, Mr. Edward B. Wall, who, on March 1, 1893, was appointed Assistant to the First Vice-President, and transferred to Chicago, with the general supervision of traffic questions arising at that point, and particularly in connection with the Columbian Exposition. This office having been abolished in January, 1894, Mr. Wall was appointed Assistant to the General Manager, with special supervision of the operations of the Purchasing Department. His long connection with the Motive Power Department and general knowledge of transportation had thoroughly fitted him for discharge of responsible duties, and his sudden death, on April 1, has entailed on our company a loss which cannot be too highly regretted.

"By order of the Board.

"G. B. ROBERTS, *President.*"

General Notes.

Detroit Graphite Manufacturing Company have a contract for painting the iron work of four of the largest buildings in Detroit, including the Chamber of Commerce building with their L. S. G. paint.

Chicago, Milwaukee & St. Paul Railway Co.—After April 15, 1894, the general offices of this company will be located in the Old Colony Building, corner Van Buren and Dearborn Streets, Chicago.

The Baltimore & Ohio Railroad Company's World's Fair exhibit, which was shipped to Baltimore at the close of the Exhibition, is now being reloaded and returned to Chicago. It has been donated to the permanent Columbian Exhibition.

Messrs. Westinghouse, Church, Kerr & Co. have removed their office to a suite of four large connecting rooms on the sixth floor of the Havemeyer Building, in New York. This is one of the few firms who report a good business in these dull times.

William C. Baker reports that he is selling some thousands of the sure safety vent for his fireproof heater to many of the most prominent roads in this country. This vent is a solid frangible disk which is sure to blow out, and thus instantly relieve any excessive or dangerous pressure in the Baker heater.

The Armstrong Manufacturing Company, Bridgeport, Conn., find a good demand for their improved pipe-threading and cutting-off machines, which are built on honor and with the view of saving time and labor in their operation. The catalogue of this concern should be consulted by those who want the latest and best in this line of goods.

The Sheffield Velocipede Car Company, of Three Rivers, Mich., has developed the business of car making in so many different directions, embracing such a variety of cars, that its title has become misleading. The word "Velocipede" has therefore been dropped from its name, and the company is hereafter to be known as the Sheffield Car Company.

The Cleveland Twist Drill Company, of Cleveland, O., report that their grip sockets are selling faster than they can make them. They have just furnished the United States Government, at the Washington Navy Yard, six of each size, from No. 1 to No. 5 inclusive, being 30 sockets in all. As the naval officials never adopt a new thing without careful investigation, this speaks well for the merit of these sockets.

Riehle Brothers Testing Machine Company, of Philadelphia, Pa., have appointed Mr. Carroll B. Smith, 32 Builders' Exchange, Buffalo, N. Y., their Selling Agent for Buffalo and vicinity for the Riehle United States Standard Testing Machines and Special Testing Appliances, the Riehle Marble Molding and Countersinking Machines, Marble Sanders and Hold Cutters, Riehle-Robie Patent Ball Bearing Screw Jacks, Screw and Hydraulic Presses, and the Riehle-Anderson Safety Track Jack.

The Hoppes Manufacturing Company, Springfield, O., have received the contract for the purifiers to supply the boilers with pure feed water for the city electric light plant, now being built by the Public Lighting Commission of Detroit, Mich. The Hoppes purifiers having been selected after very strong competition. The order calls for seven 300-H.P. purifiers to carry 165 lbs. of steam working pressure. Each purifier is required to heat and purify 9,000 lbs. of boiler feed water per hour.

The Detrick & Harvey Machine Company, of Baltimore, have recently purchased from the Capitol Manufacturing Company, of Chicago, their business of manufacturing the well-known Adams bolt threading and Cook nut tapping machines. The excellent reputation of these machines for accuracy and durability is so universally established that it is unnecessary to go into details at this time. The Detrick & Harvey Machine Company have an excellent plant; and with the increased facilities of special machinery they are prepared to turn out machines of the highest grade of workmanship.

The Joseph Dixon Crucible Company, Jersey City, N. J., are putting a cycle chain graphite on the market, which for purity of graphite and usefulness is vastly superior to anything of the kind heretofore prepared. The graphite is not only of the choicest stock, but is ground to an impalpable powder and then reground with a high grade of lubricating oil. This material when applied to the chain of a bicycle penetrates to the bearings and thoroughly lubricates and protects them from wear and rust. The Dixon Company will shortly put the same material on the market in solid form for convenience of wheelmen who wish to carry it in the tool bag.

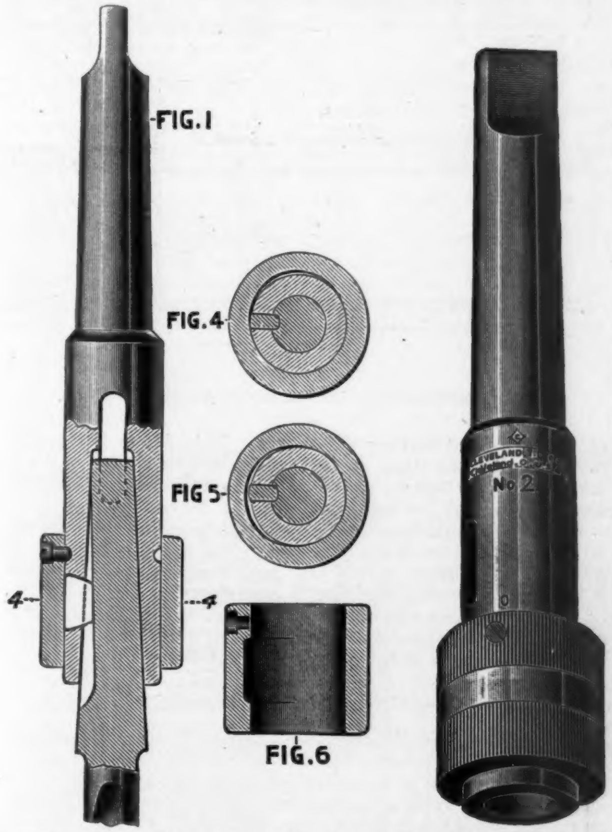
Pumps for the Navy.—Probably the largest order for steam pumps ever given out in this country by one concern was awarded to the George F. Blake Manufacturing Company by the William Cramp & Sons' Ship and Engine Building Company for a complete outfit of pumps for the U. S. cruisers *New York*, *Columbia*, and battle-ships *Indiana* and *Massachusetts*. The contract covered over one hundred steam pumps of all kinds, including independent air pumps for the main condensers, hydraulic pressure pumps for operating the guns, main and auxiliary feed pumps, main and auxiliary fire pumps, wrecking pumps, bilge pumps, water service pumps, engine-room oil pumps, drainage pumps, and steam pumps for the steam launches of the vessels named. Since the receipt of this order the George F. Blake Manufacturing Company have also closed the contract with the Cramp Company for a similar supply of pumps for the cruisers *Minneapolis* and *Brooklyn* and the battle-ship *Iowa*. The following U. S. naval vessels are also furnished with Blake pumps: *Philadelphia, Newark, Chicago, Boston, Atlanta, Maine, Puritan, Miantonomah, Manadnock, Terror, Amphitrite, Katahdin, Detroit, Montgomery, Marblehead, Yorktown, Dolphin, Machias, Castine, Petrel, Vesuvius, Iwana, Narkeeta, Wahneta*, and many others.

The Schenectady Locomotive Works are improving the opportunity of the dull times by replacing their old machine shop with a new two-story modern structure built of steel framework and brick filling. The new building will be 80 ft. in width by 368 ft. in length. The first floor will have two Sellers' electric cranes, traveling the entire length of the building, and covering all the heavy tools used on locomotive frames and driving-wheels. The Phœnix Iron Company, of Philadelphia, have the contract for the steel framework of the building, while the masonry is being done by a local builder. The B. F. Sturtevant Company, of Boston, are furnishing their blower system of steam heating, which is used with success in a number of other departments of the works. The old machine shop, now demolished, was built in 1866, replacing a structure which at that time was destroyed by fire. The machine tools have been temporarily transferred to other buildings, and set up so no delay in filling orders will be experienced during the construction of the building. It is expected the new building will be completed in June. With the completion of this building these works will be the most modern in buildings and equipment in this country, if not in the world, the entire plant having been practically rebuilt and equipped with new tools during the past ten or twelve years. The works are also about to receive a large hydraulic flanging plant for flanging boiler-work, which is about completed by the Morgan Engineering Company, Alliance, O. This is the largest and most modern plant of its kind ever constructed for this purpose.

Manufactures.

NEW METHOD OF DRIVING DRILLS.

EVERY mechanic knows that the weakest point about the ordinary taper shank twist drill is the flattened end of the shank, which frequently twists off long before the drill is worn out, or, if it does not, it will often cut or ream out the flat recess in the socket. In either event the drill or the socket are forever after useless until considerable expense has been put on them in the way of repairs. The Cleveland Twist Drill Company, of Cleveland, O., have gotten up what they call a grip socket that entirely overcomes this, the only weak point in the modern system of taper shanks. This grip socket is fully shown in the illustrations. A steel key is let into one side of the ordinary socket, and its inner side engages in a groove or flattened place prepared for it on the shank of the drill. A slight turn of the eccentrically counter-bored sleeve or collar fastens or locks the key securely in its seat, and then the drill cannot be turned in its socket or pulled out. This key is so located in the body of the socket that the tang on the drill will fit into the usual slot or recess prepared for it, and in this way the socket has a double driving power. The advantages arising from the fact that the drill cannot be pulled



out till the collar is turned back and the key released are many, as heavy tools have a provoking way of dropping out of their sockets at most inopportune times, and many drills are dulled or spoiled by tapping them into place by a hammer. If this simple drilling device is put directly on to the drilling machine spindle, heavy undercutting can be done with boring bars, and the labor necessary to turn over heavy castings entirely avoided. These grip sockets will hold just as perfectly and securely straight shank drills, and can be furnished with $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. holes for straight shank drills. The company propose to put this necessary groove in the shanks of all their drills so that they can be used in these grip sockets just as the purchaser may prefer. A drill that has had the tang twisted off can be made as good as new for use in this grip socket by milling a half round groove in the shank, or if it is not convenient to mill it, a flat piece can be filed or ground in the shank, care being taken that such groove or flat place has a taper the reverse of that on the outside of the shank, as shown in the section drawing of the illustration. The small cut illustrates the reducer or shell sockets used with the grip. The Twist Drill Company have applied the gripping device directly to several drill press spindles, and will furnish collars properly constructed for that purpose on application at a very trifling expense. They have put in special machinery for making these grips, and as all parts will be made to jigs or standards, they can furnish duplicate parts at any time.

THE BALL & WOOD COMPANY'S NEW VERTICAL ENGINE OF 600 H.P.

THIS company issued invitations to a number of engineers and others to visit their shops at Elizabethport on Saturday afternoon, March 31, to inspect a new vertical engine just completed for the Chicago Edison Company. A very "goodly" company availed themselves of this privilege, and spent some hours in inspecting the engine and works.

To the visitors "A Brief Description" of this engine was distributed, which is of sufficient interest to justify us in reprinting it:

Engineers and the public at the present time seem divided in their preferences between two types of engines—the slow speed, represented in its best form by the Corliss engine, and the high speed, in the various forms which have recently come so largely into use. The Corliss engine has been, and is now, the standard for economical consumption of steam; but the high-speed engine offers so many other advantages that, in many cases, it becomes unquestionably the better one for practical service.

Since the beginning of this rivalry between the two classes of engines, there has been a recognized place for an engine which possesses the best economy of the Corliss engine, and at the same time some of the undisputed advantages of the high-speed type, in the direction of higher rotation, smaller floor space and better regulation.

The recent advent of electrical dynamos, arranged to be placed directly on the engine shaft, has greatly emphasized the want above described, because of the great saving in cost of dynamos when higher rotative speeds are employed, and the desirability also of close regulation.

With increased rotative speed shorter stroke is permissible; and hence the vertical form of engine, with its many advantages, offers fewer disadvantages than when extremely long strokes are used.

The engine herewith described has been designed and built with the foregoing state of facts in view, and, it is believed, will meet the hearty approval of engineers.

Its chief characteristics are:

1. *Unexcelled economy*, obtained by minimum clearance spaces and correct distribution of steam.
2. *Moderately high rotative speed.*
3. *Superb regulation.*
4. *A cut off valve gear giving rapid cut off and wide opening of ports at all points* from zero to three-quarter stroke.
5. *Small floor space.*
6. *Special adaptation to driving direct connected dynamos*, by reason of the shaft being entirely unencumbered with valve gear at both ends outside of the pillow blocks.
7. *Desirability for mill work*, in the combination of economy and regulation.

A brief consideration of the foregoing features may not be uninteresting here as an accompaniment of the illustrations of this engine.

Economy of Steam.—The expression "unexcelled economy of steam" is often applied indiscriminately, and even to the most wasteful engines. Purchasers have learned to interpret this expression according to the probable performance of the engine as judged by well-known principles of steam engineering, established by careful tests. For instance, correct steam distribution and small clearance are features that are found in every engine that has made a record for small consumption of steam. The best steam distribution is undoubtedly obtained with some form or modification of the Corliss wrist-plate motion and valves, and the smallest possible clearance is obtained by placing these valves in the cylinder heads. The engine holding the world's record for economy at this writing has just this arrangement. For good reason, then, it has been adopted in the engine under consideration.

Rotative Speed.—The Corliss releasing gear practically limits the rotative speed to about 100 revolutions per minute, or less; but in the engine here described the automatic cut-off is obtained by independently operated cut-off valves placed inside the steam valves, and actuated by a specially designed governor. This arrangement places no restriction on rotative speed, which is decided by other considerations, and the aim has been to find a medium unobjectionable to the slow-speed advocates.

Regulation.—The governing mechanism of the engine must be of special interest to the student of valve gears. Beginning with a well-known form of shaft governor, the principles of which have attracted the attention and admiration of the ablest engineers of the day, the superb regulation thus obtained is made effective by transmitting the necessary motion to the cut-off valves through a special wrist-plate device, in which a compound motion is obtained, and the cut-off valves at all points of cut off operate relatively to the main valves just as though the latter were standing still, thus preventing wire drawing of steam at any point of cut off.

Wide Ports and Rapid Cut off.—The location of the valves in the cylinder head, giving as it does the shortest possible ports, permits of their being of ample capacity without an appreciable increase of clearance.

The peculiar motion of the cut-off valve utilizes these wide ports to the fullest possible extent, and the cut-off motion at every point from zero to three-quarter stroke is a rapid one, in fact as rapid as is obtained from the releasing gear, because of the higher rotative speed of the engine.

Another feature of great importance in this gear, particularly with compound engines, or where moments of excessive overload occur, is its ability to cut off at three-quarter stroke, while the Corliss gear is limited to about half stroke.

Small Floor Space.—This feature may or may not be of special interest to the purchaser. In most cases floor space is valuable, and often extremely so. The compact form of this engine recommends it particularly to those who are limited in this direction.

Direct-driven Dynamos.—While the engine that has been described is eminently suited to any service requiring stationary engines of the highest efficiency, it has special features of adaptability to the work of driving electrical dynamos built upon the engine shaft and free from any encumbrance, and may each carry a dynamo or belt wheel if desired. It has already been described in regard to its rotative speed and close regulation, both of which add greatly to its value in this service.

Manufacturing and Mill Work.—Too much emphasis cannot be given to the advantages found in uniformity of speed under all conditions of load. In spinning and weaving this is especially true; and we offer to mills something not heretofore obtainable in the combination of this regulation and steam consumption, with the further advantage of safety in the use of wheels of small diameter. Fly-wheel accidents, fatal to life and property, are common to slow-running engines possessing wheels of excessive size and inferior governing mechanism; and, we believe, in the engines of our design these serious risks are overcome.

ALUMINUM DRAWING INSTRUMENTS.

THE Bennett Manufacturing Company have submitted to us a considerable number of letters from draftsmen in different parts of the country, testifying to the satisfaction they have derived from the use of their drawing instruments made of an alloy of aluminum.

Mr. William H. Wahl, Secretary of the Franklin Institute, writes that he "finds the specific gravity of the sample of aluminum alloy you left with me a few days ago to be 2.96. Pure aluminum is 2 6.

"Considering the remarkable increment of stiffness and hardness your alloy possesses in comparison with pure aluminum, the comparatively small increase of specific gravity is interesting to note. You certainly secure these advantages without appreciable sacrifice of lightness."

At the last meeting of members of the Society of Mechanical Engineers specimens of nickel aluminum was exhibited which had been sent by Mr. Alfred E. Hunt, of the Pittsburgh Reduction Company. One specimen was a rectangular bar 18 in. long, $1\frac{13}{16} \times \frac{1}{4}$ in., which was bent in the middle and had a permanent set of $1\frac{1}{8}$ in.

"This," Mr. Hunt wrote, "had been tested under transverse test, it taking 400 lbs. to deflect the sample to the amount of the one sent, the distance between the supports being 16 in., *C* to *C*. A similar piece of 66,000 lbs. tensile strength steel, with 23 per cent. elongation in 8 in., took exactly the same load—400 lbs.—to deflect to exactly the same amount.

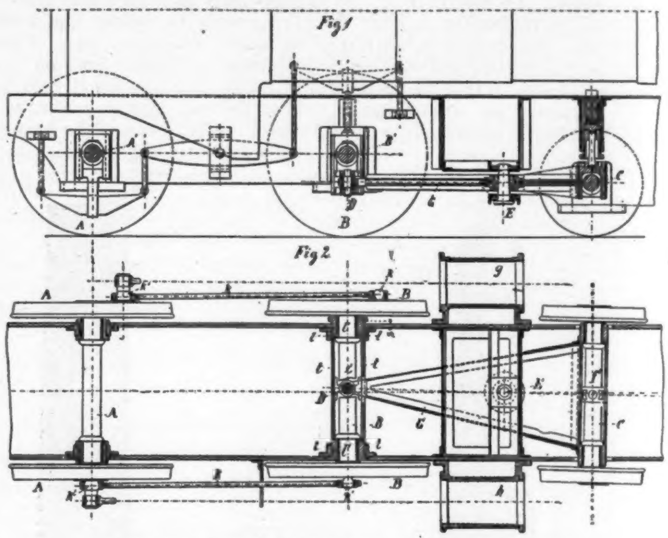
"I also take pleasure," Mr. Hunt wrote, "in sending you a sample of nickel-aluminum which has had a $\frac{3}{4}$-in. hole bored into it and enlarged by blows of a sledge upon a drift-pin to 2 in. This is a test which steel would by no means have stood."

This specimen was also exhibited. Mr. Hunt, continuing, said: "This is a new alloy which the Pittsburgh Reduction Company is just getting out, and which is a very interesting one, and promises to enlarge the field for aluminum considerably."

Recent Patents.

HELMHOLTZ'S LOCOMOTIVE RUNNING-GEAR.

RICHARD HELMHOLTZ, "a subject of the Emperor of Germany, residing at Königsberg, East Prussia, Prussia, Germany," has patented the arrangement of wheels and axles for locomotives shown in figs. 1 and 2. As will be seen, fig. 1 is a side elevation, the front part, or attachments to the truck wheels, being shown in section, and fig. 2 is a sectional plan drawn through the axles. The rear or trailing wheels *A A* are attached to an axle *A'*, which is held in axle-boxes in the ordinary way. The two boxes of the front driving-axle, *B'*, are both made in one piece and are held in jaws in the frame, and are fitted so as to have a certain amount of lateral motion which permits the axle and wheels to move with it. The truck axle-boxes on the axle *C* are made in the same way, and are free to move laterally. A triangular-shaped frame *G* is attached rigidly to these boxes, and is also pivotally connected



HELMHOLTZ'S LOCOMOTIVE RUNNING-GEAR.

at *D* to the front driving axle-boxes. This frame is also connected to the bed-plate or the smoke-box by a fixed pivot *E* and a spherical bearing shown in fig. 1. The coupling-rods *k k* are also connected to the crank-pins *k' k'* by ball joints.

From the engravings it will be seen that the front driving-wheels *B B* and the truck wheels are free to move laterally in relation to the locomotive frame, and it will also be seen that if the one pair moves sidewise in one direction that the action of the truck frame about the pivot *E* will move the other pair of wheels in the opposite direction. The number of this patent is 564,320, and is dated February 6, 1894.

VON BORRIES' COMPOUND LOCOMOTIVE.

Mr. August Von Borries, of Hanover, Germany, has patented the form of intercepting valve illustrated by figs. 3 and 4. In his specification he describes his invention as follows:

"It relates to valve apparatus for compound engines whereby an engine provided therewith can be worked at will either as a compound engine, or as a non-compound engine, as, for instance, when it is desired that the power of the engine should be temporarily increased to meet special demands above the normal working average; as, for example, in the case of a locomotive, for ascending an incline, for starting a heavy train, or for shunting rapidly. According thereto within a suitable valve case are arranged two connected piston-valves that control passages between the receiver and the low-pressure cylinder, between the receiver and the low-pressure exhaust passage, and between a high-pressure steam-pipe and the low-pressure cylinder. One of these valves, hereinafter called for distinction the exhaust-valve, is larger than the other, and serves when the engine is working compound to prevent the passage of steam from the receiver to the low-pressure exhaust passage direct. The smaller valve, hereinafter termed the steam-valve, is under these circumstances inoperative, but by admitting live steam behind it, both it and the exhaust-valve will be automatically moved into such positions that the exhaust from the high-pressure cylinder can pass from the receiver direct into the low-pressure exhaust-pipe, while the said live steam will pass at a reduced pressure into the low-pressure

cylinder, which thereby becomes for the time being a high-pressure cylinder, with a consequent augmentation of power in the engine.

"Fig. 3 and 4 are longitudinal central sections of valve apparatus constructed according to this invention, fig. 3 showing the valves in position for working the engine to which they are applied, compound, while fig. 4 shows the valves in position for working the engine as a non-compound engine.

"*A* is a valve-case formed with a high-pressure exhaust passage *B B'* adapted to form part of the connecting pipe or receiver between the high and the low-pressure cylinders, and with another passage *C C'* adapted to form part of the low-pressure exhaust pipe or passage.

"*D* is a valve, herein called the exhaust-valve; it is in the form of a piston, and is arranged to control an exhaust-port or passage *E* connecting the two passages *B B'* and *C C'*, and to control the flow of exhaust steam through the passage *B B'* from the high to the low-pressure cylinder.

"*F* is a valve, herein called the steam-valve; it is in the form of a piston, and is arranged to work, as shown, in a cylindrical portion or extension *A'* of the valve-case provided with a steam inlet *G* that is in communication with the main steam-pipe, or direct with the boiler, or is adapted to be placed in communication with either by a cock or valve that may be worked by hand or from the reversing rod, or by a suitable construction of regulator valve, as will be readily understood without drawings.

"A^2 is an opening for placing the front end of the extension *A'* in communication with the atmosphere, so that the valve *F* can make its outstroke easily.

"The two valves are connected by a rod *H*. The steam-valve *F* is arranged to control the passage between the said inlet *G* for live steam and the valve-chest of the low-pressure cylinder or cylinders. In the arrangement shown the rod connecting the exhaust and steam-valves *D F* is solid and made in two parts of different diameter, the part *H'*, of larger diameter, being arranged to work through a partition or diaphragm *A** placed between the cylinder in which the steam-valve *F* works and the passage *B B'*, and prevent live steam flowing freely to the low-pressure cylinder or cylinders until the exhaust-valve *D* is fully opened, as shown in fig. 4, at which time the part H^2 of the rod of smaller diameter will extend through the hole in the said partition or diaphragm,

valve-chest of the low-pressure cylinder or cylinders, so that the engine will then work as an ordinary high-pressure or non-compound engine. When the supply of live steam to the steam inlet *G* is cut off, the valves will by reason of the greater pressure on the exhaust-valve of steam within that part *B'* of the receiver between the valve-case and the steam-chest of the low-pressure cylinder, return automatically to their normal positions shown in fig. 3, and the engine will again work as a compound engine.

Fig. 3.

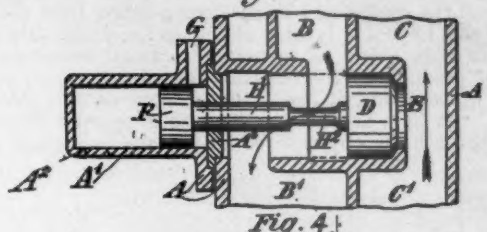
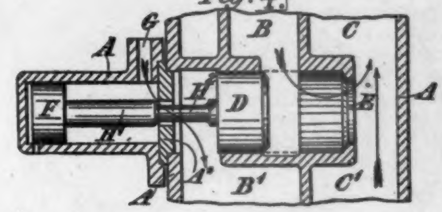


Fig. 4.



VON BORRIES' COMPOUND LOCOMOTIVE.

"When the engine is working non-compound and the thicker part *H'* of the valve-rod will have passed out of the hole in the intermediate plate or partition *A**, and formed a steam passage of such size as to reduce the pressure of the live steam that is then flowing through this hole (by throttling it), in such manner that the total force of the full pressure on the smaller valve *F* is kept equal to the total force of the reduced pressure on the larger valve *D*. As a consequence of this arrangement the following important results are obtained: If

Fig. 5.

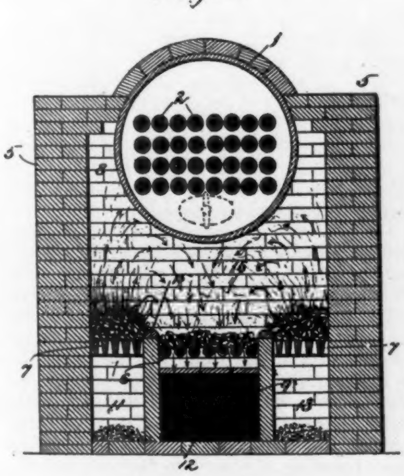
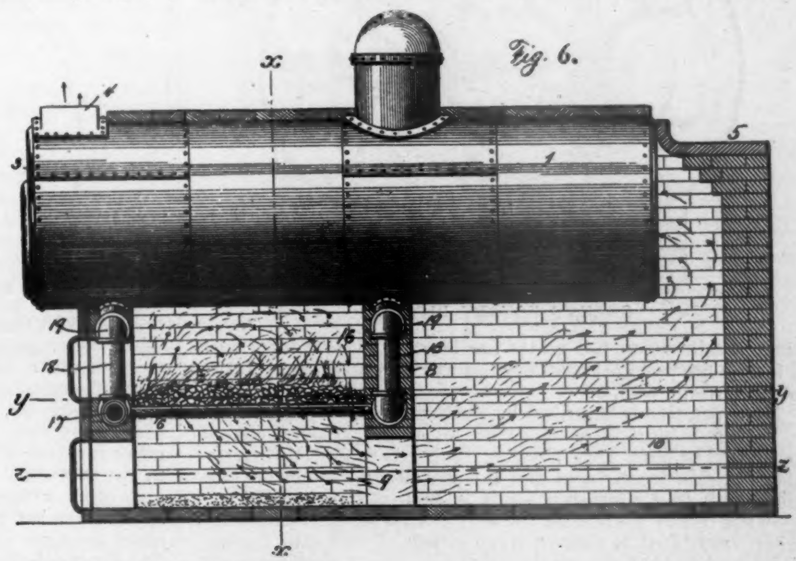


Fig. 6.



PLUMMER'S SMOKELESS BOILER.

and leave a free passage for live steam to the end *B'* of the said passage *B B'*, whence it can flow to the low-pressure cylinder.

"By the arrangement described, when live steam is admitted through the said steam inlet *G*, so as to act behind or upon the inner end of the valve *F*, the two connected valves *D F* will be automatically moved by the pressure of the live steam on the steam-valve *F* into the positions shown in fig. 4. Th exhaust-valve *D* will then close the passage *B B'* between the high and low-pressure cylinders and open the exhaust port or passage *E*, so that each cylinder can exhaust separately into the exhaust-pipe or passage *C C'*, and the steam-valve *F* will occupy a position in which the part H^2 of the rod connecting the valve will extend through the hole in the partition or diaphragm *A**, and leave an annular opening, as shown, that will effect a communication between the main steam-pipe or boiler and the

the consumption of steam at the reduced pressure in the low-pressure cylinder becomes greater, the pressure in the passage *B'* will be reduced a little thereby, causing less force on the larger piston and motion of both pistons to enlarge the opening H^2 through plate till the right amount of reduction is again reached. If the consumption of lower pressure steam is reduced, the pressure in *B'* will increase a little, thereby causing the pistons to move back a little and reduce the size of the opening H^2 till the right reduction is again reached.

"The amount of reduction is proportionate to the areas of piston-valves *F* and *D*. Thus if the smaller one is one-half the area of the large one the pressure in *B'* will be reduced to one-half. Furthermore, this arrangement possesses the excellent feature of reducing the steam pressure in *B'* to the proper amount to enable the total pressure on each piston to be equal when working non-compound, thereby preventing too great a

strain on the working parts, and enabling the adhesion of the driving-wheels of a locomotive to be utilized in the most advantageous manner."

The patent is No. 511,581, and is dated December 26, 1893.

PLUMMER'S SMOKELESS BOILER.

This invention contemplates a novel combination of a down-draft water-grate 6 and one or more up-draft fire-grates 7. (See figs. 5 and 6.) These different grates are relatively located with a series of solid grate-bars forming a separate fire-grate on each side of the water-grate. There is a single bridge-wall 8 over all the grates, and this is distinguished from the usual bridge-wall in that it is fitted closely to the under side of the boiler or other object to be heated, so as to prevent any passage of products of combustion between it and said object; or, in other words, it has an imperforate surface above the grates, but it is arched or otherwise supported across the space beneath the object to be heated, and in a plane below

Fig. 7.

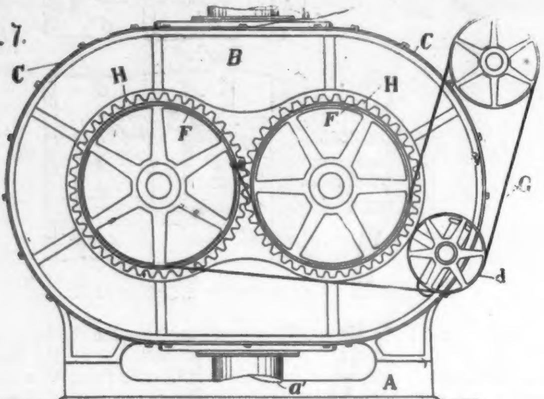
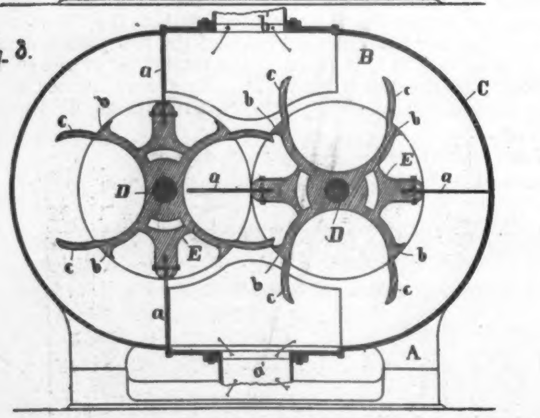


Fig. 8.



GREEN'S ROTARY BLOWER.

the plane in which the grates are located, so as to form what I term a fire-passage 9 centrally beneath the imperforate portion of said bridge-wall.

The operation is described by the inventor as follows:

"A fire is built in contact with all of the fire-surfaces and permitted to burn until glowing coals are produced thereon; then the side fire-surfaces and the central fire-surface are supplied with fuel alternately—that is, so that there would be a glowing bed of coals upon the said central fire-surface always when fresh fuel is thrown upon either of said side fire-surfaces, and so that the smoke from said side fire-surfaces will be caused to pass downward through said bed of glowing coals carried by said central surface, said central surface being supplied with fresh fuel at times when said side-surfaces have located upon them, or one of them at least, a glowing bed of coals. It will thus be observed that the central fire surface with its down-draft grate acts not only to consume the smoke generated by itself, but it acts as a smoke-consumer for the products of combustion discharged by the fire-surfaces located on each side and closely adjacent it, with the result that the smoke produced by all of the fire-surfaces is consumed prior to its discharge into the smoke-stack or chimney of the furnace."

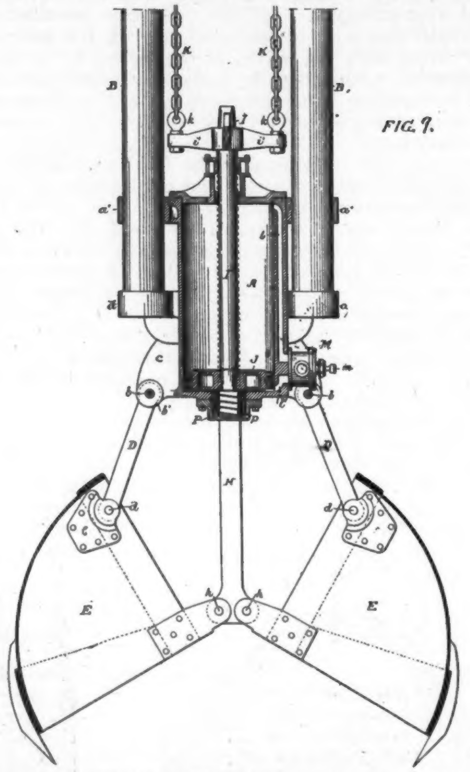
It would seem as though the operation of this grate would be improved if the side grates were made inclined toward the middle one, so that raw coal to be fed on the side grates and when it becomes incandescent could be moved to the middle or down-draft portion.

The inventor is William S. Plummer, of St. Louis. His patent is numbered 514,869, and is dated February 13, 1894.

GREEN'S ROTARY BLOWER.

Figs. 7 and 8 represent a very ingenious form of blower, which has been patented by Mr. Thomas W. Green, of Philadelphia, on February 20, 1894 (No. 515,212). The following general description from his specification with figs. 7 and 8, which represent respectively an outside and sectional view, will make the construction of this machine clear to the reader:

"I mount upon suitable driving-shafts, *D D*, lying in a support parallel to each other and inclosed in a proper air-tight casing, *C*, two iron frames *E, E*, commonly called revolvers. Each of these revolvers is provided with two blades or wings, *a, a*, for taking in the air or other fluid, and has the parts lying between the said wings or blades formed in such shapes that those parts of the two revolvers will fit into and upon each other as the revolvers turn around and thus form a lock or cut-off to prevent the escape of the air or water taken



SYMONDS' DREDGING-BUCKET.

in, except by the outlet provided and in the manner described. The two wings on each revolver are located exactly opposite to each other, and the cut-off mechanism midway between each of said wings. The revolvers are secured upon their respective driving-shafts in such a position that when the wings of one revolver are in a vertical position, the wings of the other revolver will lie horizontally and exactly at right angles to the first one. This position will allow the wings to pass each other without striking and the cut-off mechanism of one revolver to act in conjunction with the similar parts on the other revolver and thus forming a complete lock or cut off. The exact relative position of each revolver is positively maintained by means of two gear wheels secured upon the ends of the respective driving-shafts."

SYMONDS' DREDGING-BUCKET.

A, fig. 9, represents a cylinder provided with pockets, *a*, and guides or holding eyes, *a'*, in which are secured the opposite guiding poles, *B*, usually employed on dredging buckets and which extend as usual through guiding eyes at or near the extreme end of the boom. At the lower end of the cylinder are rocker-shafts *b*, which extend across the opposite sides of the cylinder and are adapted to suitable bearings *b'* thereon, the bearings being further supported by strengthening ribs *c* forming part of the cylinder.

Near each end of the shafts *b* are secured links *D*, which extend down to the opposite sections *E, E'* of the bucket and are pivoted at *d* to the bucket sections; the pivot point being strengthened by plates *e* secured to the inner surface of the

bucket and adapted to receive the pivot-pin *d*. The cylinder is provided with guides through which pass vertical connecting bars *H*, pivoted at their lower ends to ears *h*, on the inner or adjoining edges of the bucket sections and at their upper ends being rigidly secured to the arms *i* of a cross-head *I* carried by a piston-rod *I'*; the cross-head being provided also

Fig. 10.

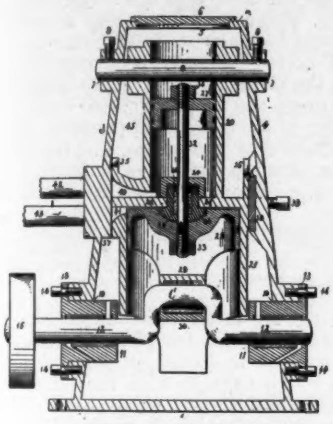
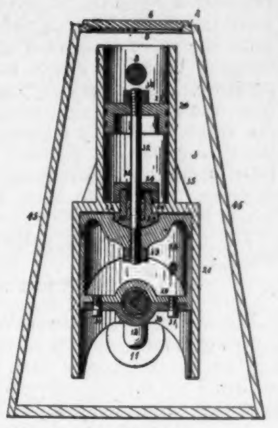


Fig. 11.



TRUESDELL'S COMPOUND OSCILLATING ENGINE.

with arms *i'* extending at right angles to the arms *i*, and being provided with eyes *k* to which are connected the chains *K* extending to the winding drum. The piston-rod *I'* is connected to a piston *J* of any suitable construction, and the cylinder is provided with the usual ports *l*, *l'* and a valve *M* controlled by cords extending from a lever *m* secured to the valve, to any suitable operating device on the dredge. The lower end of the cylinder is provided with a pocket, *P*, in which is a spring, *p*, adapted to cushion the piston when the bucket is opened.

In operation the parts are lowered by the chains *K* with the bucket open, as shown, and when the bottom is reached, the operation of the valve *M* admits fluid below the piston *J*, which forces it upward and thus carries the piston-rod *I'*, cross-head *I*, links *H* with it. As the portions *d d* of the bucket are held down by the superincumbent weight, the upward movement of *H* tends to turn the sections *E* and *E'* about the pins *d d* and thus close the bucket.

The weight of the bucket and the cylinder casing and the poles all tending to keep the bucket close to the bottom, while the pressure of fluid between the piston and the end of the cylinder causes the gradual closing of the jaws of the bucket and the latter is completely filled without any undue strain on the operating parts, as distinguished from the ordinary construction of buckets, where the operation of the hydraulic or other cylinder usually acts to raise the bucket during the closing movement and prevents the weight of the parts acting to keep the bucket at the bottom. During the descent of the bucket the piston *J* being at the bottom of the cylinder and resting against the spring *p*, the contact with the bottom is not detrimental to the machine and any sudden shocks or breakage are avoided.

The inventor of this device is Mr. Thomas Symonds, of Leominster, Mass. His patent is dated February 13, 1894, and numbered 514,788.

TRUESDELL'S COMPOUND OSCILLATING ENGINE.

Figs. 10 and 11 represent an ingenious form of engine, patented by Eugene E. P. Truesdell, of Belvidere, Ill. It hardly needs any description, as the engravings make the construction sufficiently clear. The high and the low-pressure cylinders 20 and 21 are cast in one piece and are suspended on the shaft 8, on which they can oscillate. The two pistons 27 and 28 are both attached to the rod 32, and the lower or low-pressure piston is connected directly to the crank *C*. The design, as will be seen from the engravings, is very crude, but the general plan by its general simplicity has much to recommend it. The patent is No. 515,180, dated February 20, 1894.

ATWOOD AND PERKINS' ENGINE.

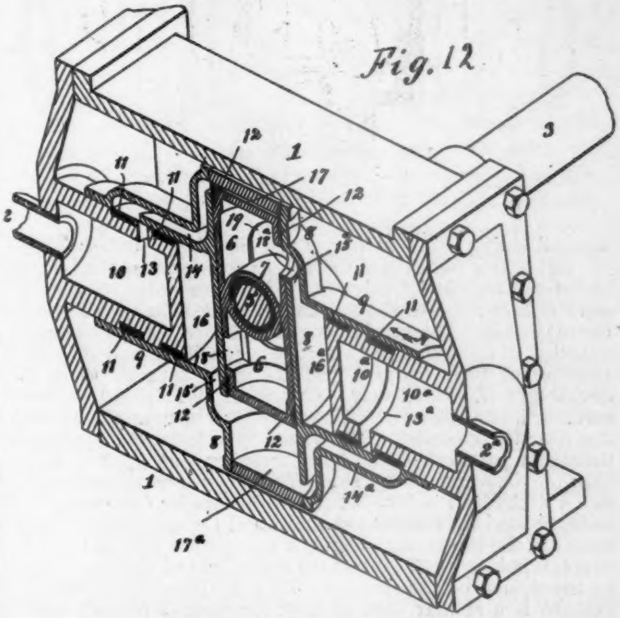
Fig. 12 represents another ingenious form of compound engine patented by La Motte C. Atwood and N. W. Perkins, Jr., of St. Louis, Mo. In their patent the inventors say:

"Our invention relates to an engine in which there is a piston and a cylinder acting alternately on the crank of a shaft, to produce a rotary movement of the shaft; the piston acting to move the crank-shaft a quarter revolution, the cylinder then acting to move the crank the next quarter of a revolution, the piston then acting to move the crank another quarter of its revolution, and the cylinder then acting to move the crank the next and last quarter of its revolution."

Fig. 12 is a sectional isometric perspective view of the cylinders.

"The operation is as follows: Supposing steam or air to enter the hollow piston 10, through pipe 2, it will pass through the ports 13 and 14 to the space 17 between the upper head of the barrel 8 and the piston 6, causing the descent of the piston 6 and moving the crank 5 a quarter of its rotation, and at the same time carrying the cylinder 9 and barrel 8 to the right, until the latter is close to the end of the piston 10ª. As the crank 5 completes this quarter of its movement, the chamber 17 is opened to the chamber 16ª, through the port 15ª, and the air or steam, exerting its pressure between the barrel 8 and the end of the piston 10ª, will cause the cylinder 9 to be moved in the direction of the arrow *A*, and cause the crank 5 of the shaft 3 to be moved another quarter of its revolution, which carries the piston 6 to its lower position. The ports 13ª and 14ª are now opened to admit steam or air into the chamber 17ª beneath the piston 6. This causes the upward movement of the piston 6, and causes the crank 5 to turn the third quarter of its revolution, and moves the cylinder 9 still further in the direction of the arrow *A*. As the crank 5 completes this third part of its revolution, the port 15 is opened to the chamber 16, and the cylinder 9 is moved in the opposite direction to that indicated by the arrow *A*, causing the crank 5 to complete the last or fourth part of its revolution, and bringing the parts again into the position shown in fig. 1, and then the operation is repeated. The air or steam exhausts from the chambers 16 and 16ª through the ports 15 and 15ª, and passages 18 and 18ª,

Fig. 12



ATWOOD & PERKINS' ENGINE.

in the piston 6 and barrel 8, and from there through a passage 19 into the interior of the housing, from where it escapes through an exhaust pipe.

"With this construction it will be seen that no valves are employed, other than those formed by the piston and cylinder themselves moving with relation to their ports. The engine, the inventors say, is an exceedingly simple and durable one, and is not likely to get out of order."

Their patent is No. 514,054, dated February 6, 1894.

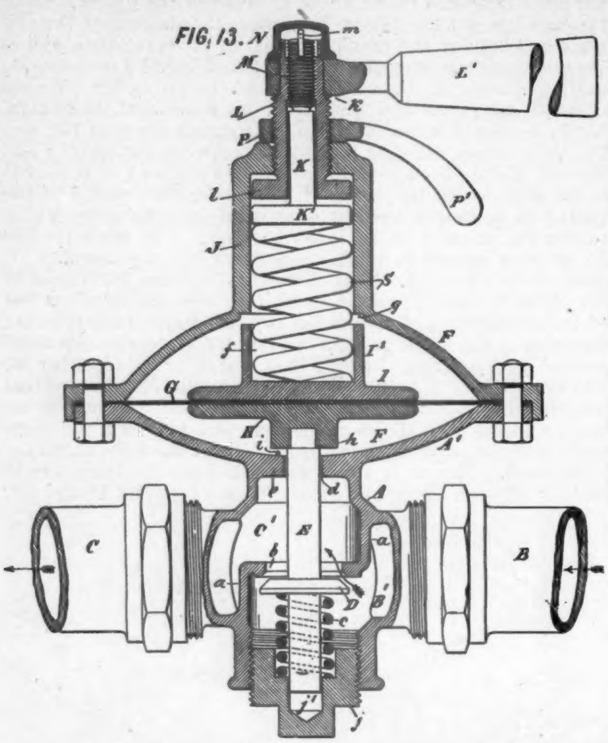
GOLD'S PRESSURE REGULATOR.

The inventor of this device (fig. 13), Mr. Edward E. Gold, of New York, says of his invention that "it relates to reducing valves for reducing a fluid from a higher to a lower pressure, and especially to such valves as are adjustable in order that the pressure on the eduction side of the valve may be regulated at will. Pressure regulators of this character are commonly constructed with a regulating valve for choking or closing the steam passage through the casing of the regulator, and with a diaphragm exposed to the pressure on the eduction side of the valve and receiving the tension of a spring, so that while the spring tends to throw the valve open, the pressure of the steam against the diaphragm tends to close it. The fluid pressure on the eduction side of such a regulator is pro-

portional to the tension of the spring, so that by adjusting this tension from time to time the pressure may be varied at will. For this purpose a screw spindle having an operating handle is commonly provided."

Its construction is described as follows :

"Let *A* designate the valve casing, *B* the induction pipe, and *C* the eduction pipe. Within the valve casing is a parti-



tion *a* dividing it into induction and eduction chambers *B'* and *C'*, and in this partition is formed a valve-seat *b* against which closes the regulating valve *D*, which is mounted on a valve-stem *E*, and receives the upward pressure of a spring *c* tending to close it. The valve casing *A* is formed with a diaphragm chamber *F* consisting of two halves or shells *A'* and *F'* bolted together at their margins and clamping between them the diaphragm *G*, which may be made of sheet metal or other suitable flexible material. The chamber *F* communicates with the eduction chamber *C'* by means of a restricted opening *d* through a partition *e*, this opening being very slightly larger than the diameter of the stem *E* which passes through it, so that a slight leak is left between the stem for the passage of steam around the eduction chamber and the diaphragm chamber. On the top of the stem *E* is mounted a disk or head *H*, which is held pressed against the under side of the diaphragm by the tension of the spring *c*. On the upper side of the diaphragm is a similar disk or head *I*, which is formed with a tubular upward extension *I'* forming within it a socket *f*, and in this socket the lower end of the regulator spring *S* is seated. This spring extends up within a chamber *J*, and its upper end presses against the enlarged head *K'* of a plunger *K*. The upper end of the chamber *J* has a screw-threaded opening through which passes a screw spindle *L*, the threads of which screw up or down in the opening when the spindle is turned by its handle *L'*. Within the spindle *L*, which is made tubular, is an adjusting screw *M* whose threads engage internal threads in the spindle, and whose lower end receives the upward thrust of the plunger *K*. On the spindle *L* is screwed a cap *N*, which serves the double function of concealing the screw *M* and holding the handle *L'* in place on the screw spindle. When the screw spindle *L* is adjusted up or down by turning the handle *L'*, it is clamped in position by a lock-nut *P*, which is provided with a handle *P'* for convenience in turning it.

"The induction pipe *B* being connected to a steam boiler or other reservoir of fluid under pressure, and the eduction pipe *C* being connected to a point at which it is desired to use the fluid at a lower pressure, the regulator serves to choke back the flow of fluid sufficiently to reduce its pressure to the required extent. The spring *S* being adjusted to the proper tension to accomplish this result, exerts a downward pressure upon the disk *I*, and consequently upon the diaphragm *G*, which pressure is communicated through the disk *H* and stem *E* to the valve *D*, and serves to press the valve open whenever the pressure on the eduction side of the valve falls below that pressure to which the regulator is set. As the valve is opened and steam passes through it and increases the pressure in the eduction chamber, steam flows from the latter through the space *d* into the diaphragm chamber *F*, and exerts an upward pressure upon the diaphragm until this upward pressure is sufficient to overcome the tension of the spring and press the diaphragm upwardly, whereupon the spring *c* will press the valve *D* upward against or nearer to its seat, thereby choking back the steam and correspondingly reducing the pressure. As the pressure on the eduction side of the valve falls, the spring again presses down the diaphragm and opens the valve, so that by a balancing of the downward pressure of the spring and the upward pressure of the steam, the regulator is caused to admit steam through the valve with just sufficient rapidity to keep up the pressure beyond it to that which is required."

The number of the patent is 508,133, and the date November 7, 1893.

HUMPHREY'S WRENCH.

The object of this invention (fig. 14), it is said in the patent, is "to provide means for forcing the movable jaw of the wrench against the stationary jaw after said movable jaw has been adjusted by the adjusting-nut which engages with the shank to which the stationary jaw is secured.

"*A* designates the stationary jaw to which the shank *A'* is rigidly attached, said shank passing through the handle to which it is attached by a nut as shown. The stationary jaw is provided on one side of the shank with a flat face *a* adapted to engage a nut, while on the other side of the shank the jaw is extended and provided with a curved face *a'* having dove-tailed recesses in which are secured steel bits for grasping a pipe or tube. The clamping faces of the movable jaws are constructed similar to those of the stationary jaw, and by providing these faces the wrench can be used upon either a nut or pipe.

"The movable jaw, *B*, is provided with an aperture through which the shank passes, and on one side of said jaw are formed ears *b* between which is pivoted a lever *C*, and said lever is connected to a movable slide *D* by means of a short link *E*. The slide engages with the adjusting-nut *F*, said nut having an aperture threaded to engage with the threads on the shank of the wrench. The link *E* is bifurcated at its end which is pivoted to the lever, and at its other end is a projecting portion adjacent to which is formed shoulders which are adapted to bear upon the slide *D*, and the lever is so constructed that when the free end thereof is moved toward the shank or handle of the wrench to its fullest extent it will bear upon the projection *d*, and when in this position the pin which connects the link with the lever will be located on the inside of a line connecting the pivot-pin in the jaw and the one in the slide ; thus locking the lever.

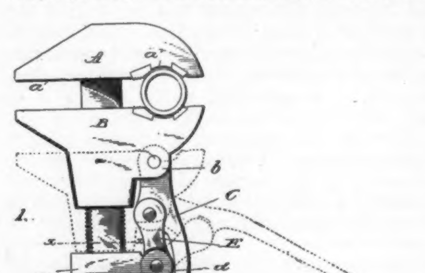


Fig. 14.

"By this device the movable jaw can be adjusted to the proper distance to grasp a nut or a pipe, and when it is desired to release the wrench it is only necessary to move the lever away from the shank or handle ; or if desired the adjustment can be made and the lever employed for forcing the movable jaw toward the stationary jaw and upon the object to be grasped."

The patentee is Edgar A. Humphrey, of Columbus, Pa. His patent is numbered 514,752, and dated February 13, 1894.